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ENGINEERING • CONSTRUCTION • OPERATIONS

PIPE LINE INDUSTRY

AUGUST
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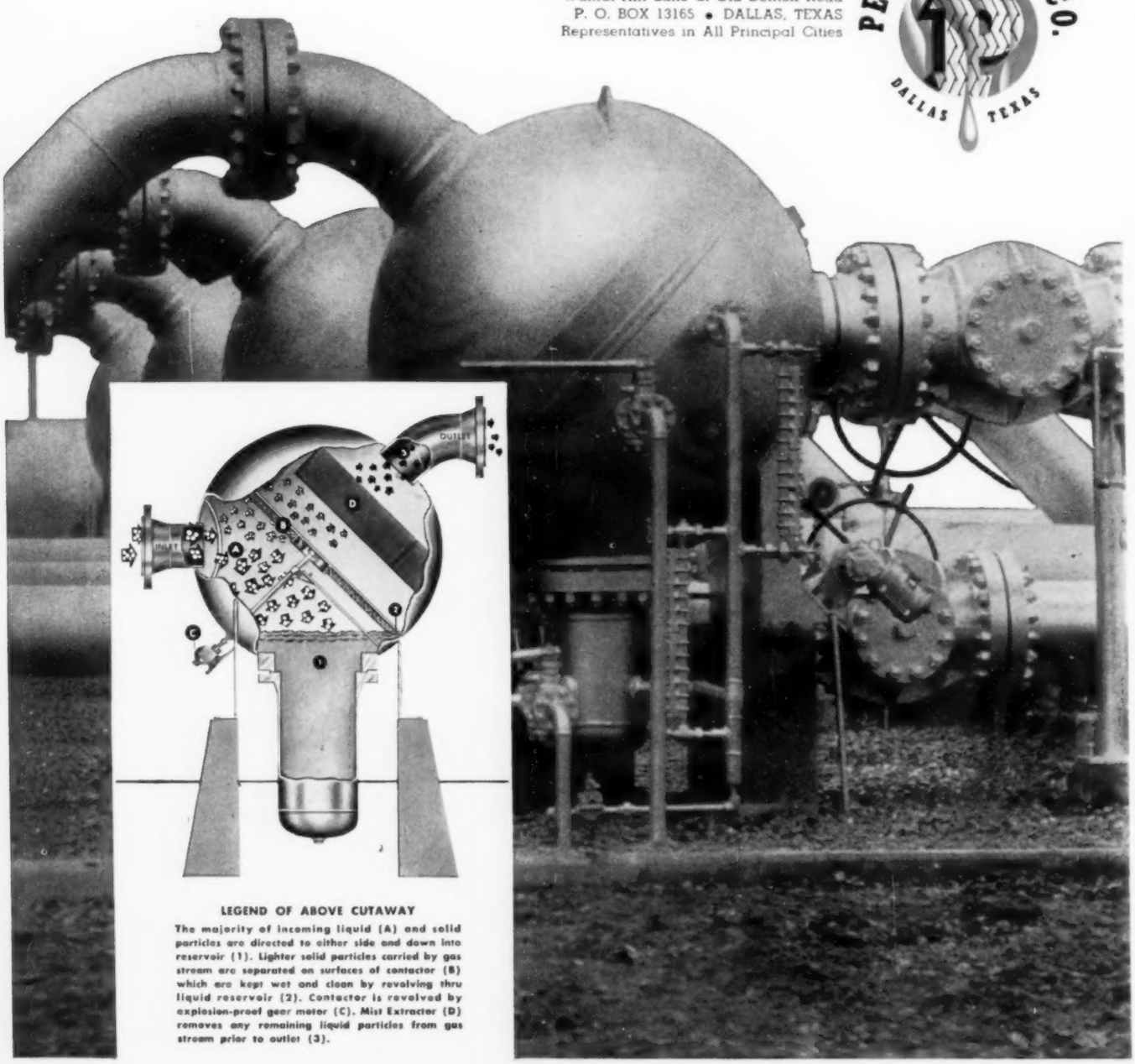

LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

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PIPE LINE INDUSTRY

CONTENTS and Quick Look

August 1959 Vol. 11, No. 2

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

Continuous Fluoroscopic Inspection of Line Pipe

☐ A new method, developed by National Tube and Battelle Memorial Institute promises much in the way of improved inspection of line pipe at the mill. Accuracy and clarity of image compare favorably with conventional X-ray film, and the cost is low. This technique should improve the quality of pipe.

By A. B. Wilder and E. B. Henry, Jr. ..... Page 26

How to Use Aerial Photos in Pipelining

☐ There's more to interpreting aerial photos than just spotting hills and gullies. Careful and expert study can reveal possible landslides, soluble bedrock below the surface, slumping formations, permafrost and subsurface rock. Also, the photos will show gravel deposits and sand that can be used for construction.

By J. D. Mollard ..... Page 31

Comparing Calculated Flow With Actual Pipe Line Flow

☐ Nothing in the design of crude and products pipe lines is more fundamental than flow calculations. They are the basis of line sizing, pump station sizing and even operating costs. Yet the industry does not have a truly accurate formula for calculating these values! Experimental work carried out in France's National Hydraulic Laboratory at Chatou, France, and on the Le Havre-to-Paris products line is a step forward.

By J. B. Capdeville ..... Page 35

Cut Down Your Employee Turnover Rate

☐ Employe turnover cannot be completely eliminated but it can certainly be reduced from an excessive rate. Here is an article which will keep you from winning the White Elephant award for the country's highest turnover rate. Make sure you read this article which starts on ..... Page 41

Install Flow Controls and Use Laterals for Gas Storage

☐ It can mean a savings for both pipe line and distribution company. The idea is quite simple. The controller at the pipe line tap, prevents excess flow but lets the lateral line reach approximate line pressure. When peak demands come, flow rate from the line remains the same, and excess is met from storage in line.

By Joseph A. Bonner ..... Page 44

A New Approach to Pressure Surge Analysis

☐ Until now, analysis of pressure surge problems has been largely graphical and based on semi-empirical methods. The basis of such work has been water hammer studies. Oklahoma State University studies have shown that the problems can be solved by techniques developed by electrical engineers. If successful, this will add a new precision to the design of crude and products lines.

By Robert D. Kersten ..... Page 46

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PIPE LINE INDUSTRY published every month. Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

Let's not sit idly by

The Mines and Mining Subcommittee of the House Interior and Insular Affairs Committee has undertaken a study of major importance to the oil industry and one which the government and the public should evaluate with extreme care.

This is a study of U.S. mineral policies in connection with House Resolution 177, which calls for a broad review of minerals programs in all executive departments and agencies of government.

Since government petroleum policies are factors in the maintenance of U.S. supremacy in the field of energy supplies and since oil and natural gas supply almost three-fourths of this nation's energy requirements, what oil industry policies the government revises or adopts are certain to exert a strong force on the industry's status in the years to come.

By and large, the oil industry in this country has grown into its dominant position in the energy field as a result of a government of the people which, through the administering of its policies, has fostered private capital initiative.

Although the federal government and the oil producing states together have developed oil policies which obviously have been successful, there is every reason to support an informed and thorough study of existing policies so improvements or revisions, if needed, can be made.

How thorough this study will be remains to be seen; however, with the effort goes the earnest hope of the oil industry that it will be a searching investigation. If so, it not only will be timely and important to this country's future economy and security but also it can be expected to shed light on industry's needs.

While this congressional study likely will assess current policies affecting numerous phases of the oil and gas industry, including federal regulation of natural gas producers, imports, use of public lands, taxation of oil and gas production, etc., the subcommittee is urged to consider the current percentage depletion provisions. Certainly, its views on this subject, as well as on others included in its study, can be expected to affect future decisions. And it is as important as ever—perhaps more so—that percentage depletion be considered.

Existing since the inception of the income tax law because of the recognition that a producer's capital asset, as extracted from the ground, must in all fairness not be taxed as income, the current percentage depletion rates does not fully recognize the facts of economic life—that the cost of finding oil has increased appreciably during recent years.

Whether a congressman has established himself as an opponent of oil cannot—or should not—affect his recognition and understanding of fundamental economics. Because continued increases in costs are affecting the oil industry just as assuredly as they are affecting every other item on the market.

And the oil industry itself has an opportunity to take a positive step in connection with this current congressional study. Instead of merely assuming the role of spectator and hoping for government and public knowledge and understanding to grow out of the subcommittee study, the oil industry *should undertake an active public relations effort to acquaint the public with policies and issues which affect the industry.*

That is what steel—and other industries—have done and are doing. And with good results, too. Full page ads are being purchased to tell the public the true facts about steel industry economics.

The oil industry can present the truth about depletion, imports, federal control, prices, and other issues which are so important to the government, the public and the industry.

If the oil industry fails to take advantage of this opportunity to collectively and individually inform the public now, another chance to gain fuller understanding will have been lost.

But, if the oil industry does act now, through its associations and societies, its future will be greatly improved through the goodwill and understanding that await public enlightenment.

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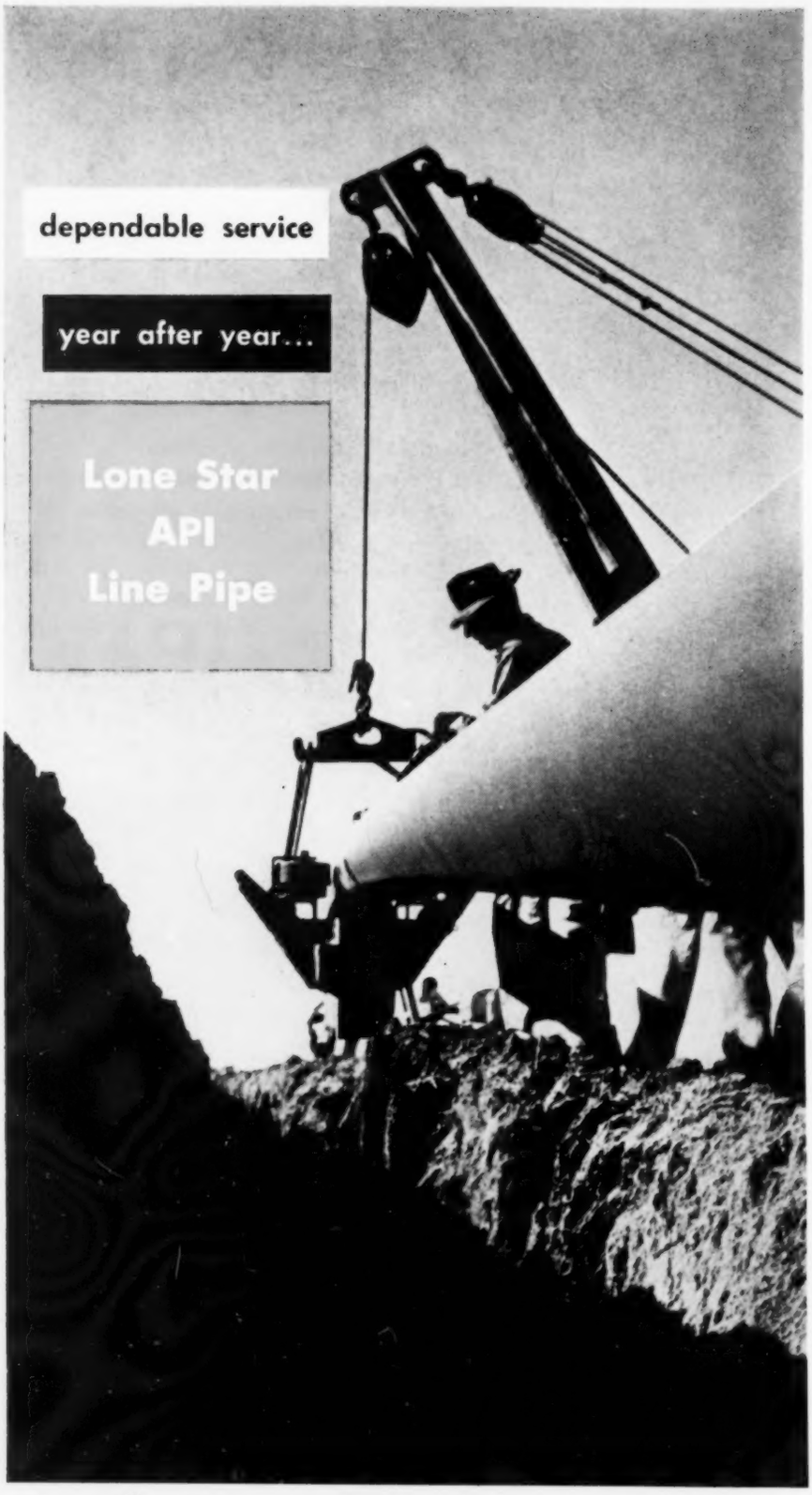

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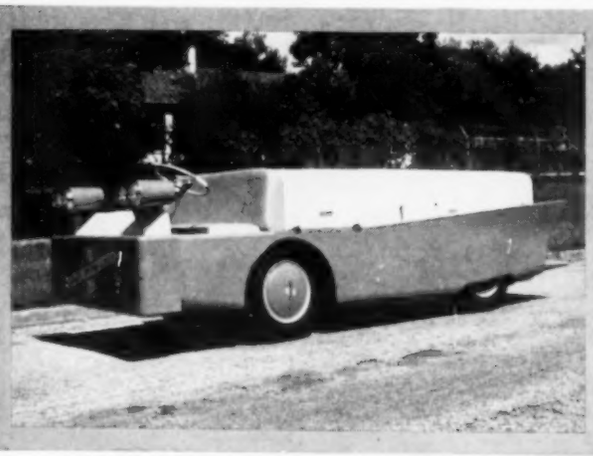

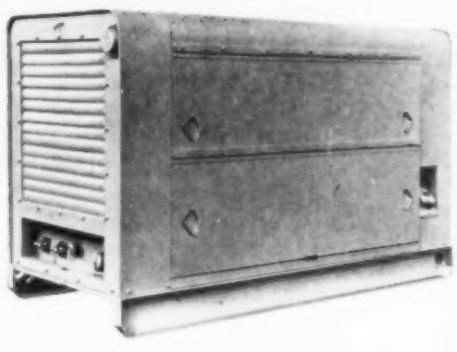

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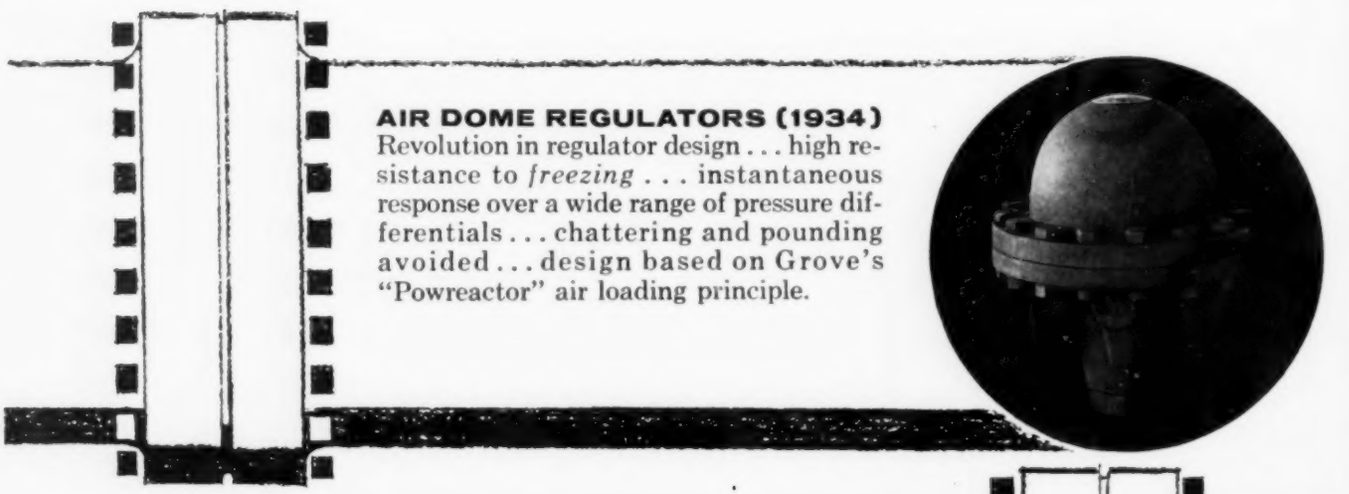
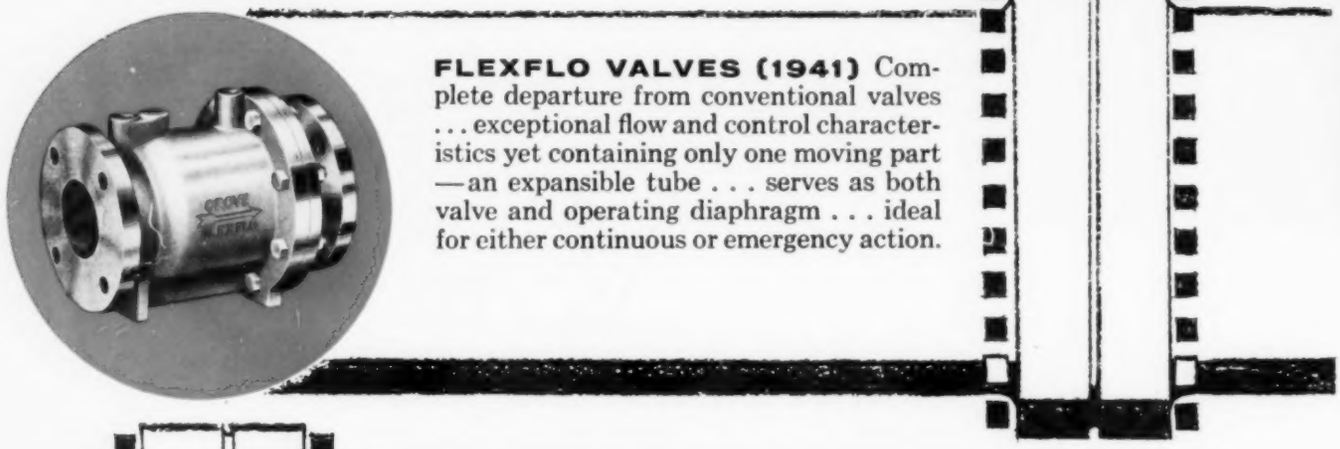


AIR DOME REGULATORS (1934) Revolution in regulator design . . . high resistance to *freezing* . . . instantaneous response over a wide range of pressure differentials . . . chattering and pounding avoided . . . design based on Grove's "Powreactor" air loading principle.



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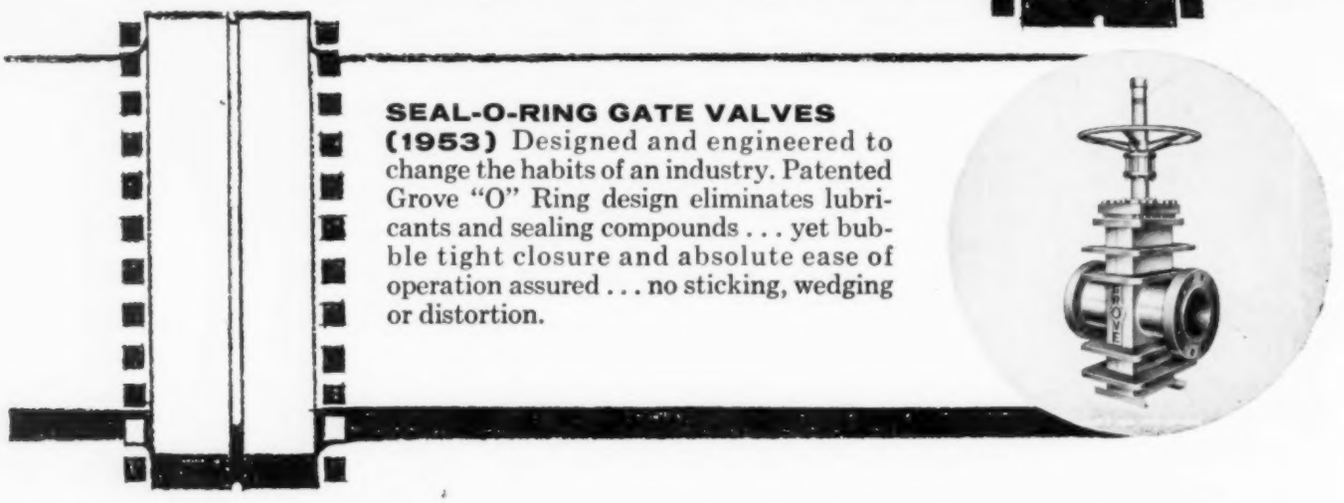

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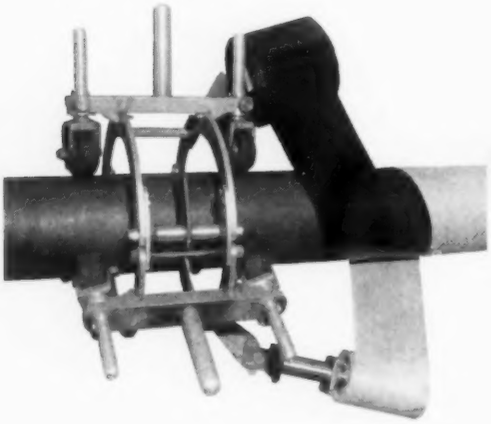

The MYOCO Tapemaster can use four arms to give any combination of tape and kraft or felt. Six various size machines available for ½" thru 36" pipe; small machines use tape from ½" width thru 9", large machines use 9" thru 18" tape.

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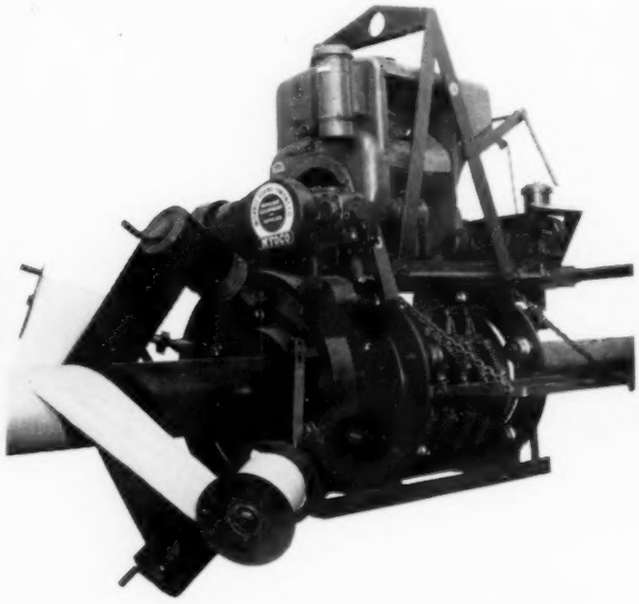

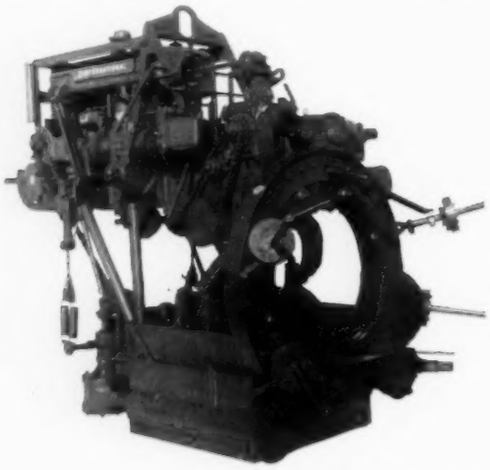

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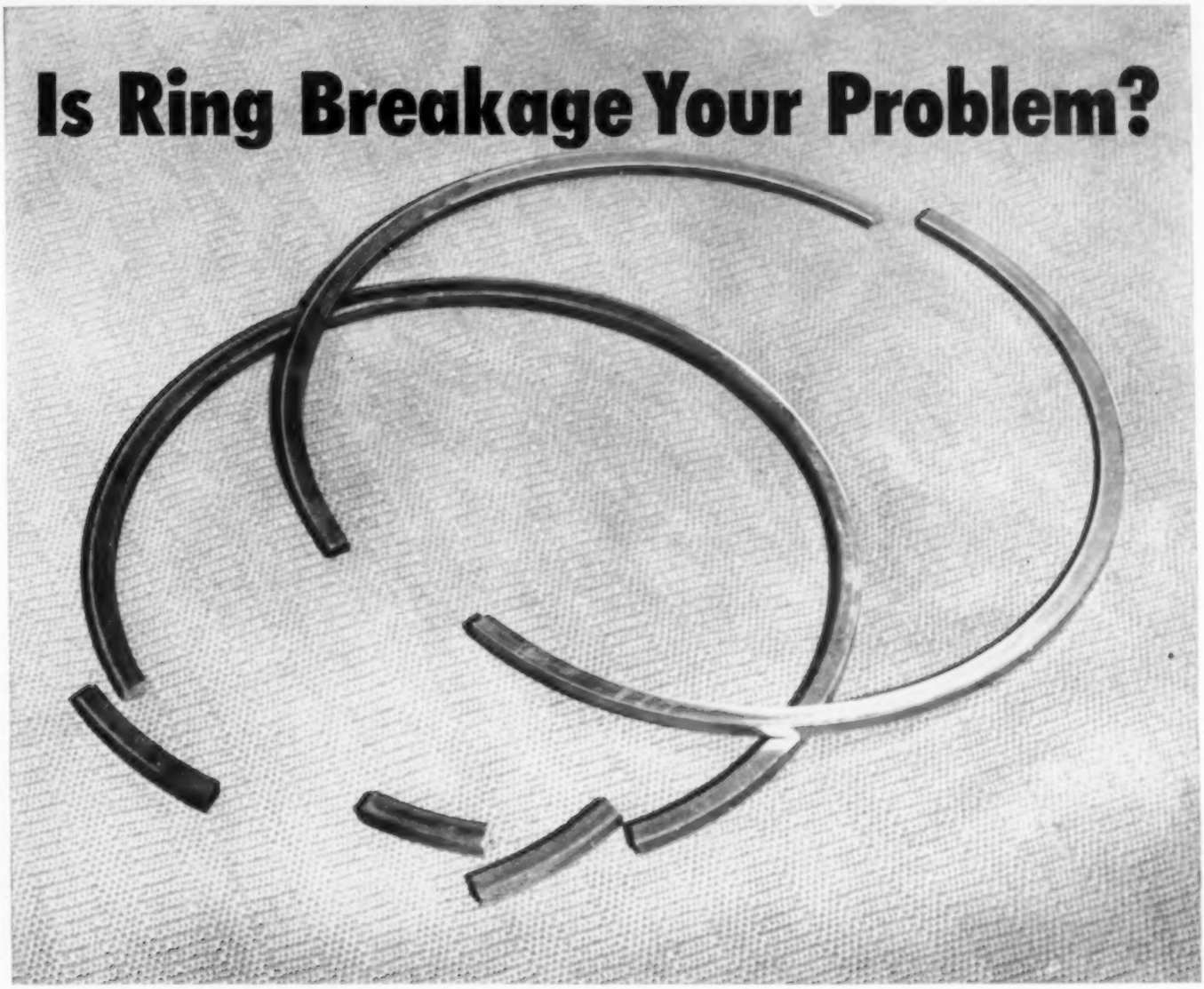

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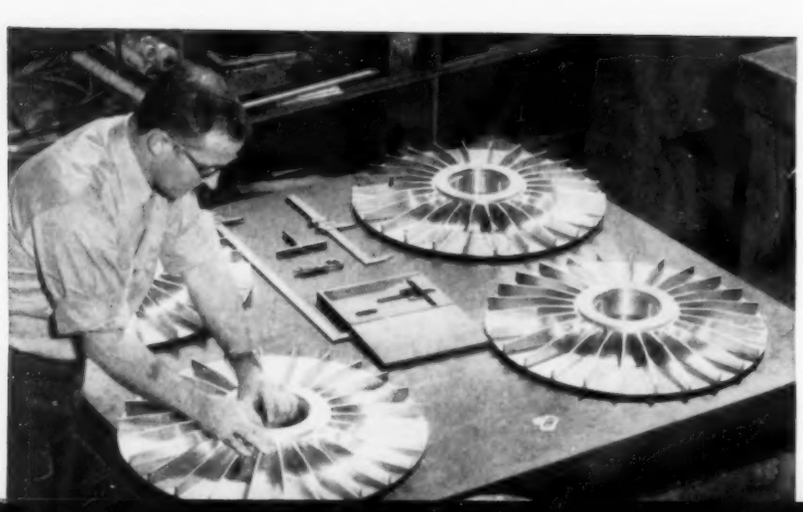

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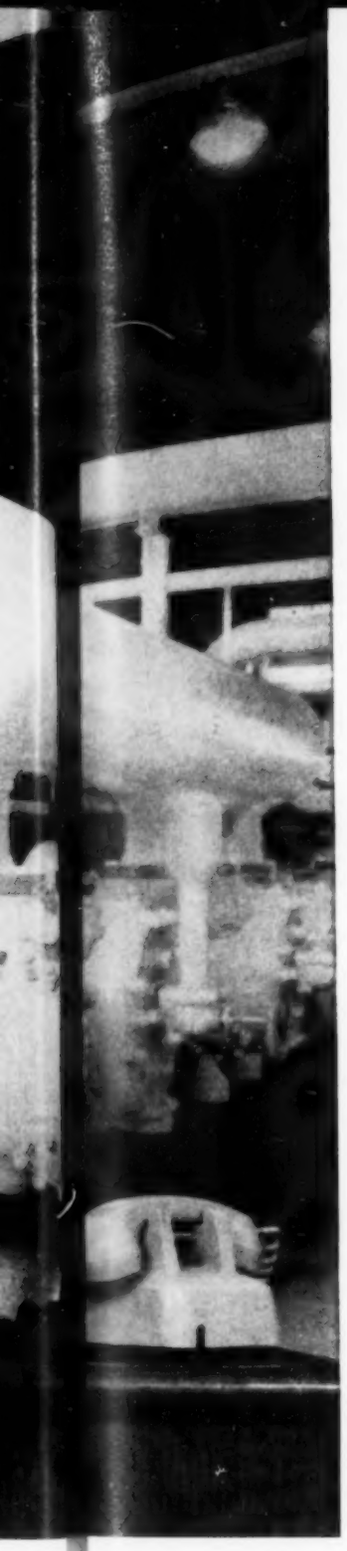

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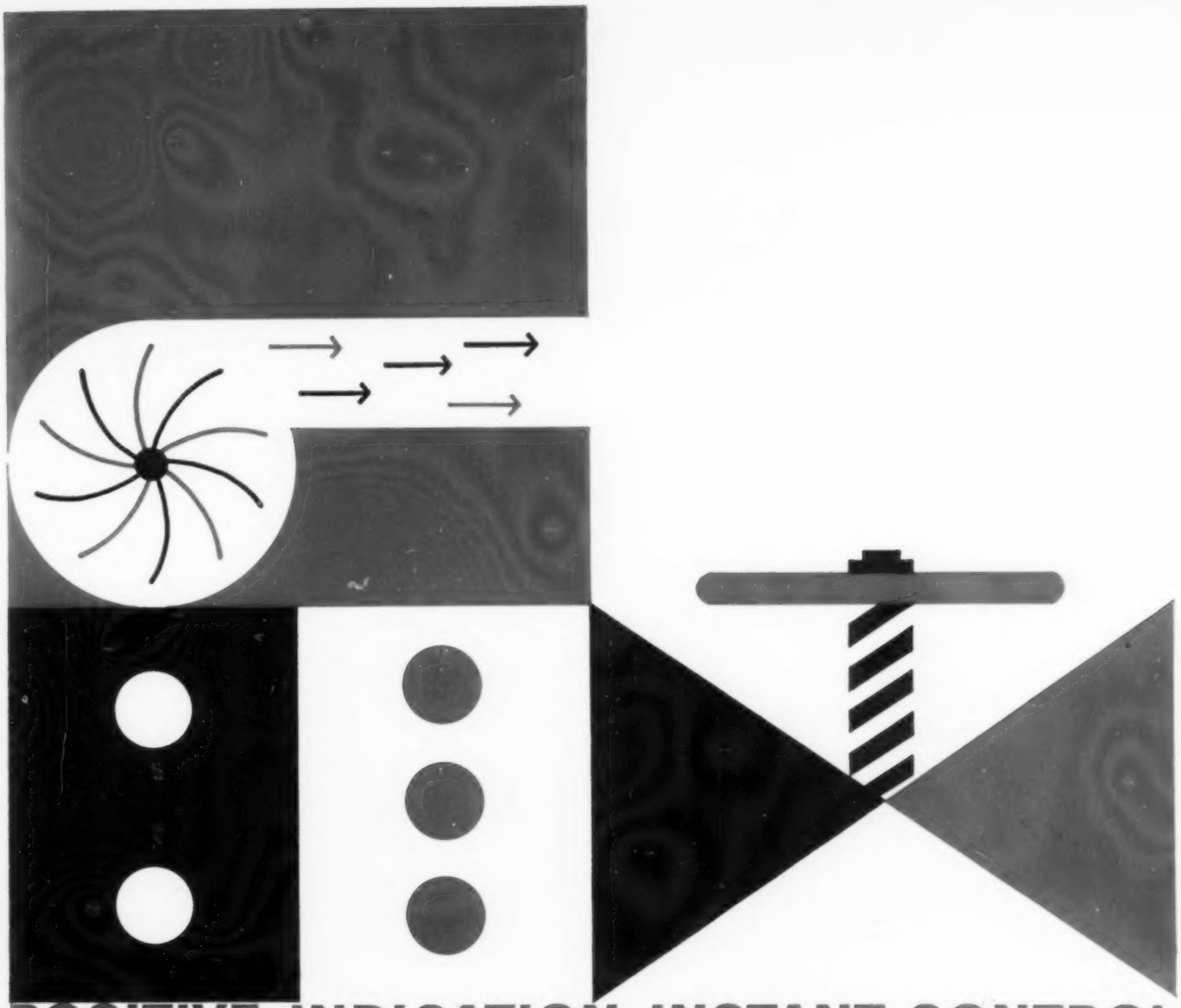

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says Calvin D. Hembree, President
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"We designed special bodies for our oil well cementing rigs to keep all the equipment and 250 bags of cement under cover. This requires a rugged truck and Ford's Tandem Tilt chassis has worked out so well that we've ordered two more.

"One of the main reasons for switching from 200 hp diesels to Ford's Super Duties was low initial price plus parts and service availability. We saved $3000 initially and at the time of an engine overhaul, we save another $2500 and nine days' downtime.

"Our drivers really like the tilt cab for its maneuverability. They maintain a speed of 30 to 35 mph on the grades, which is approximately 10 mph faster than the comparable diesels could go. Everyone around here is sold on the performance and reliability of the Fords. We find they stay on the job with less maintenance."

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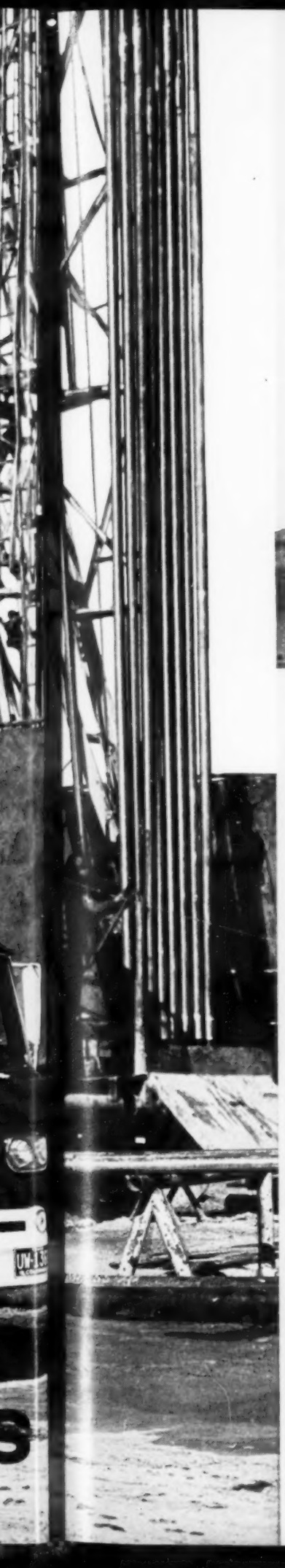

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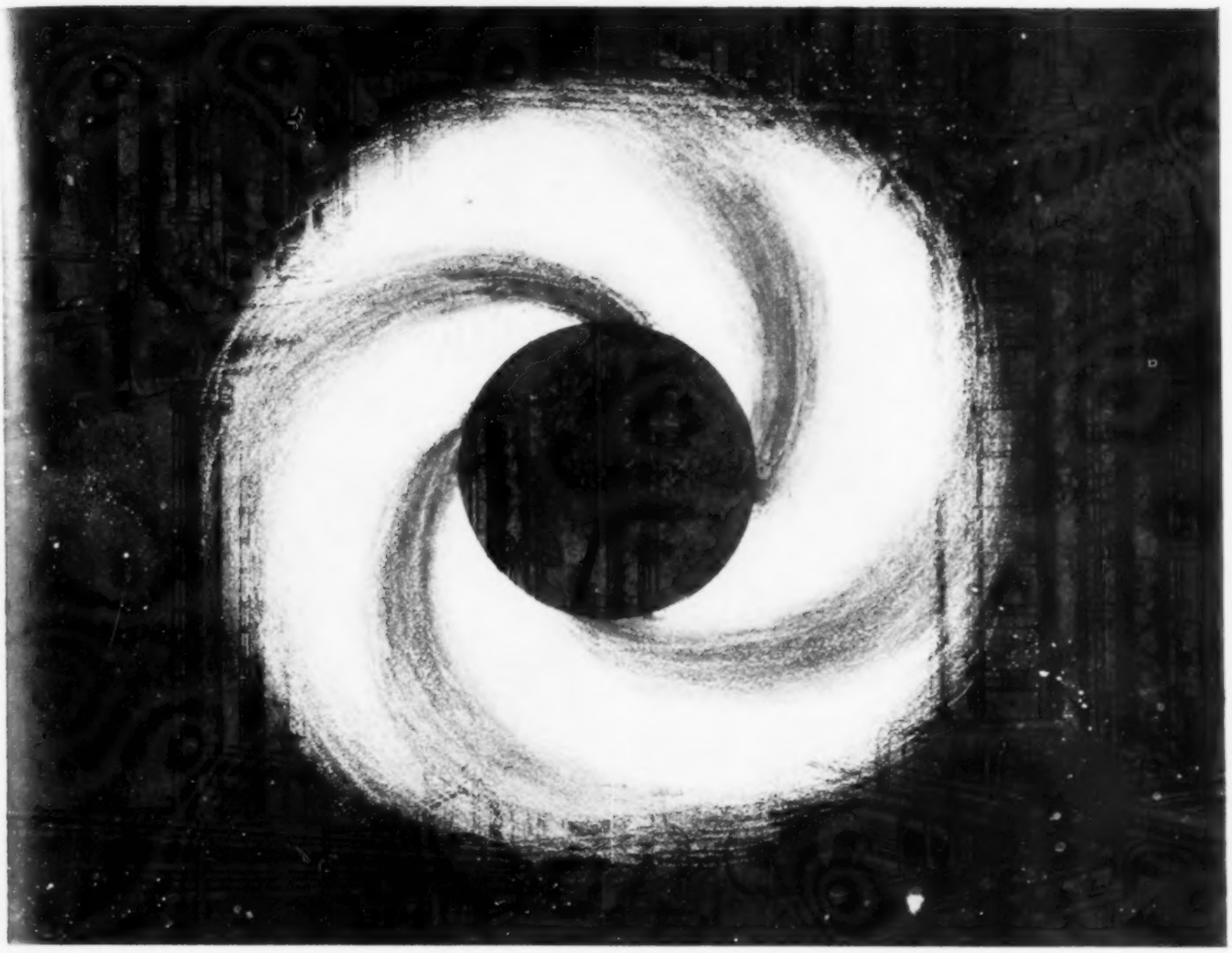

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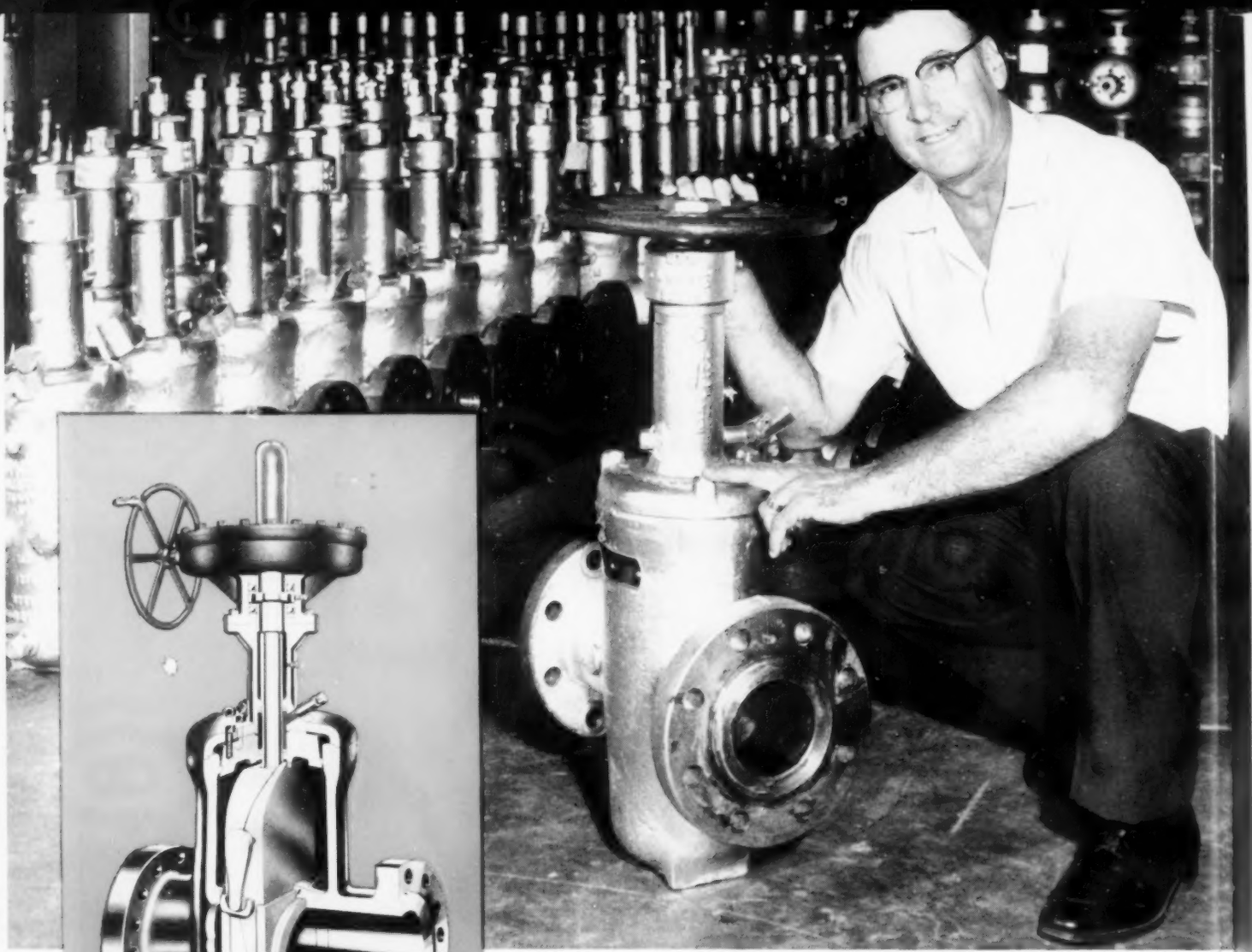

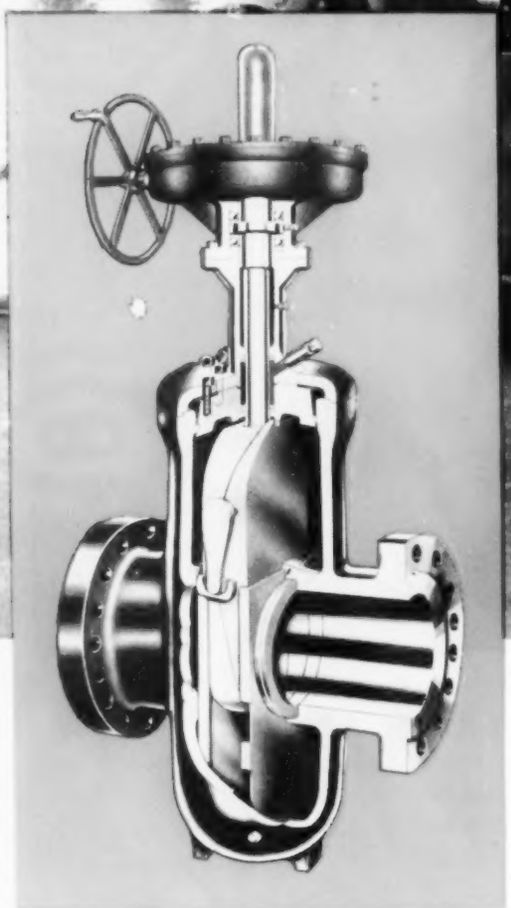

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PIPE LINE PANORAMA

Steel Strike Will Not Affect Projects . . . Pipe Line Industry survey of major pipe line companies reveals that enough pipe and other steel goods were purchased in advance of steel strike to insure continuation of most major construction and expansion programs in 1959.

Should unions get 10 cents per hour wage hike as U.S. Labor Department spokesmen have predicted, steel prices may increase 2-5 percent before year's end.

Italians Use Pipe Line for Data Transmission . . . Experimental tests on different types of Italian pipe lines have proved, with some qualifications, that an electrically insulated buried pipe line may be compared to the conductor of a physical line, and therefore used for remote transmission of data with the ground as second conductor.

Equipment used includes an audio-frequency oscillator, two variable resistors and two voltmeters. Sound reproduction type low distortion power amplifiers are used.

Italians report that cost of method is limited to data transmitting and receiving equipment and amplifiers. Method can be used to control cathodic protection, performance of gas distribution systems, measurement collecting system in radio dispatching installation.

Frequency of electrical continuity failure is virtually non-existent, thus line safety is high. Maintenance costs are negligible. Line attenuation is drawback which limits application to short distances (6.25 miles), unless adequate equipment is used.

U.S. companies are conducting similar tests.

Pipe Line Labor Trends . . . According to Labor Department statistics, the construction industry exceeded all others in man days of idleness caused by strikes during 1958. About two-fifths of the idleness resulted from five stoppages involving 100,000 workers.

Pipe Line Contractors Association reports that by mid-July, pre-job conference reports had been received from Pipe Line Local 798 on 78 jobs totaling 3,410 miles. Fifty of the jobs (64.1 percent of total) were set up on 60-hour week. Only 17 jobs (21.7 percent of total) were set up on seven tens.

Operating engineers in Southern California have new contract with A.G.C. calling for 25 cents per hour increase for next three years. New rate for top operators is $4.01 plus 15 cents welfare.

Washington Panorama . . . F.P.C. has taken under advisement Transwestern's proposal to build 1,809-mile, $191.7 million gas line from Texas to California. Squabble continues over prices, with Commission staff counsel charging that proposed rates (45 cents at California border) are higher than any ever granted by F.P.C. Nevertheless, favorable decision, with possible price restrictions, is expected soon . . . **Natural gas pipe line sales** totaled 8.51 billion mcf, during 1958, representing 4.5 percent increase in sales and 11.3 percent in revenues . . . **F.P.C. has given Texas Eastern green light** to purchase leases and royalty interests in Louisiana's gas-rich Rayne field for about $180 million, and take 101.7 Mmcf of gas daily from the field's nearly one trillion cubic feet of reserves . . . **Spokesmen for American Petroleum Institute** recently told Federal Communications Commission the oil industry will need 40 percent more spectrum space in next ten years. They added that the oil industry has already invested $45 million in radio equipment, and would be using 10 to 25 percent more if air waves weren't already overloaded.

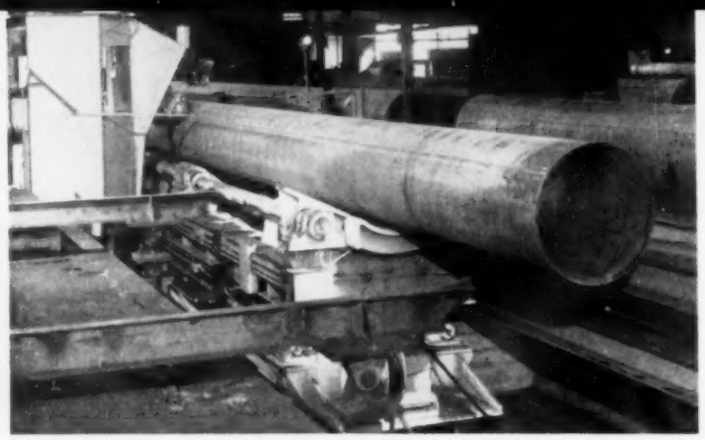


FIGURE 1—Fluoroscopic unit in pipe mill production line between expander and end facers. Joint is in position for inspection.

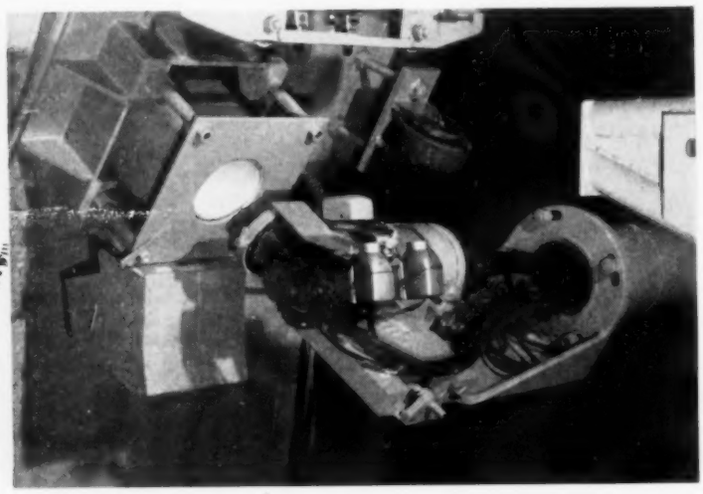


FIGURE 2—View of X-ray head and front face of fluoroscope. Early production unit has been proving highly efficient in detecting any flaws in longitudinal weld area of line pipe.

FIGURE 3—Operator at control board of fluoroscopic pilot installation. The operator can adjust pipe as he views fluoroscope image through binoculars.

Filmless X-Ray

Continuous Fluoroscopic Inspection

A new image intensifier makes it possible to inspect about 20 joints per hour. This can mean better pipe in the future

By A. B. Wilder, Chief Metallurgist
E. B. Henry, Jr., Senior Research Electrical Engineer
National Tube Division U. S. Steel Corp.
Pittsburgh, Pa.

A FLUOROSCOPIC inspection unit, installed in the pipe mill production line between the expander and end facers at National Tube's McKeesport, Pa., plant has been proving highly efficient in detecting flaws in the longitudinal weld area on line pipe. The unit is the result of experimental work done at Battelle Memorial Institute. It processes about 20 joints of 40-foot pipe per hour.

The development of commercially available image intensification systems led directly to National Tube's sponsorship of a feasibility study of fluoroscopic pipe inspection. Objectives of this investigation were:

1. To establish the feasibility of fluoroscopy with image intensification as a production inspection tool for large diameter submerged arc welded pipe.
2. To ascertain operating characteristics including sensitivity, speed of operation, most desirable method of image presentation, etc.
3. To make recommendations as to the type of X-ray and fluoroscopic equipment that would be most suitable, as well as the general charac-

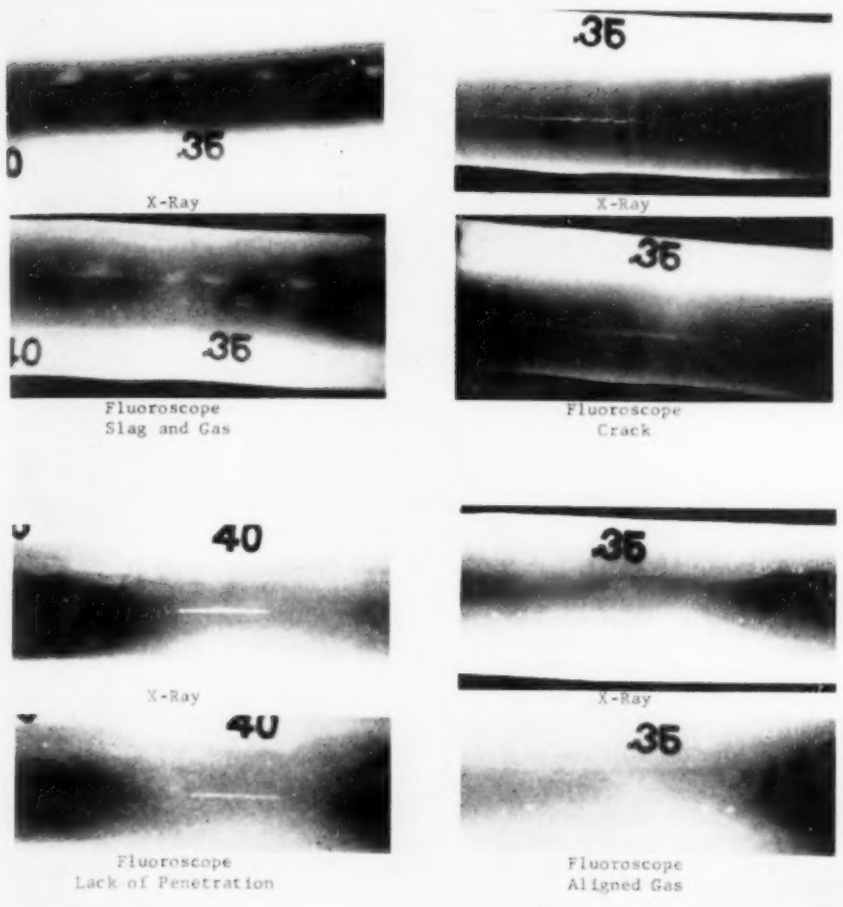


FIGURE 4—Comparison of negative photos of fluoroscopic images and conventional X-ray films. Fluoroscope images are positive rather than negative. These typical weld defects were observed in pilot installation.

# of Line Pipe

teristics of the pipe handling machinery required.

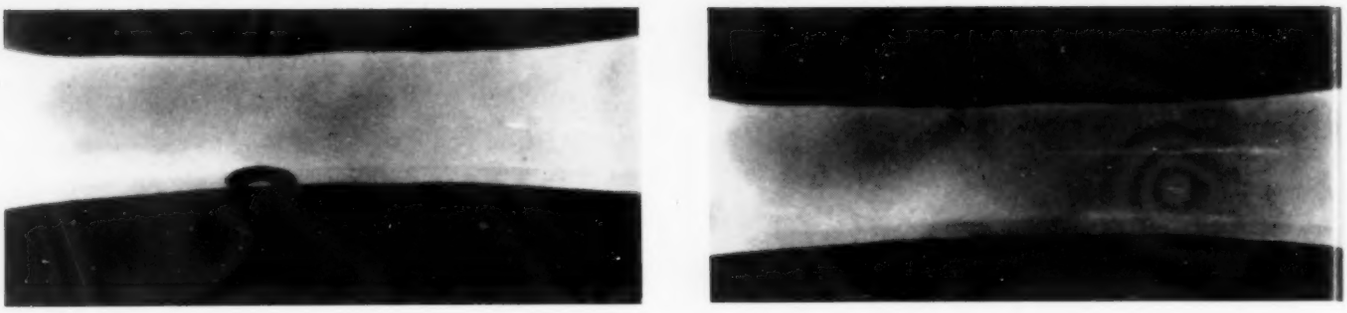
Early experimental work. Experimental work at Battelle was limited to the examination of eight samples of submerged arc longitudinal weld pipe. These samples were from line pipe each containing a section of weld through its center; with 7 to 9 inches of material on either size of the weld, and 20 to 25 inches in length. Laboratory-type radiographs were made of welds which included slag, aligned gas, lack of penetration, lack of fusion, cracks, and sound welds. These radiographs were made with extreme care as they were to serve as controls for this project. One percent sensitivity was achieved for most samples and 2 percent for all.

Two industrial image intensifiers were investigated in this project. Two percent contrast sensitivity was achieved with each unit, but what was more encouraging was the fact that the imperfections normally encountered in this material were detectable with a minimum of training and that speeds compatible with mill operations were possible. As a result of this investigation it was decided to purchase the necessary equipment for an experimental installation at National Works, McKeesport.

Pilot installation. To ascertain the practical radiographic characteristics and the mechanical, electrical, and safety requirements for a permanent mill installation, this equipment was placed in operation on an experimental basis at McKeesport. This installation included equipment capable of examining ten foot pipe sections and provided for continuous control of pipe speed and direction. Arrangements permitted a further evaluation of the performance of the fluoroscope under conditions similar to those encountered on the production line. Performance charactertistics for the pipe handling equipment, X-ray and fluoroscopic equipment mounting and positioning tolerances, radiological safety, and electrical requirements could also be determined with this equipment.

Binocular viewing of the image appeared to be less fatiguing to the operator than a mirror system, and therefore the intensifier with a binocular was chosen for this work. Also, since the work at Battelle had supported the theory that a small focal spot X-ray source will cast a sharper X-ray "shadow" and thus result in a sharper fluoroscopic image, a small focal spot X-ray source was chosen for this work. The X-ray machine selected had a minimum head clearance diameter of 10 inches which permitted a selection of two focal spots: 0.4 and 2.5 mm rated at 150 KV constant potential at 3.0 or 12.0 milliamperes respectively. The 0.4 mm spot approaches a point source giving sharp image outlines and although the 3.0 ma current may appear small, constant potential operation and short source to screen distances make this amount of radiation sufficient.

The X-ray head was mounted at the end of a boom and connected by high-tension cable to the high voltage generator located near the opposite end of the boom. Complete control of the X-ray head was accomplished at the control console located at the operator's position in a shielded booth. Means were provided for horizontal adjustment of the X-ray head position on an axis common with the longitudinal axis of the image intensifier tube. Thus the focus screen distance was controllable by push-button from



Lack of Penetration | Crack

FIGURE 5—TV screen reproductions of fluoroscopic images tried during pilot run. Binocular viewing proved superior.

the operator's position in the booth.

The pipe conveyor consisted of a four-wheeled cart on which were mounted two pairs of rollers designed to cradle various sizes of pipe. Means were provided on the carriage for both vertical and lateral adjustment of the pipe. Speed adjustment is accomplished by means of a separate hydraulic control valve in the booth. This arrangement permits the operator to pass the pipe over the boom in such a manner that the longitudinal weld passes directly between the X-ray source and the input screen of the image intensifier.

The evaluation of equipment sensitivity was made on a basis of ability to actually observe weld deficiencies. Although the equipment was originally designed to handle full-size pipe sections ten feet in length, a bracket was added to handle samples containing defective welds from rejected pipe. Over 50 of these samples were selected for examination in addition to several full size pipe sections. They were examined without previous knowledge of the nature or extent of the imperfection. For each sample examined the pipe number, wall thickness, radiographic data, and a description of the defect were recorded. These were compared later with the actual X-ray inspection negatives and were found to be similar.

Results of this phase of the investigation were recorded by photographing the fluoroscopic image through one of the oculars of the binocular viewing system and also preparing a film radiograph of the sample using the same X-ray equipment under the identical radiographic conditions. X-ray positives were printed and used to compare the fluoroscopic photographs. The fluoroscopic photographic image was small and had to be enlarged for direct comparison with the radiographic positive.

Mill experience indicated the fluoroscope to be capable of rapid detection of imperfections currently rejected by radiographic techniques provided reasonable care was exercised in the mechanical alignment of the X-ray head, the fluoroscope, and the pipe weld. The limits of misalignment were 1/16-inch in the vertical direction and ¼-inch in the horizontal direction. A speed of 15 fpm was adequate for the detection of small imperfections and the larger defects were detectable at greater speeds. Consequently, it was recommended that pipe handling

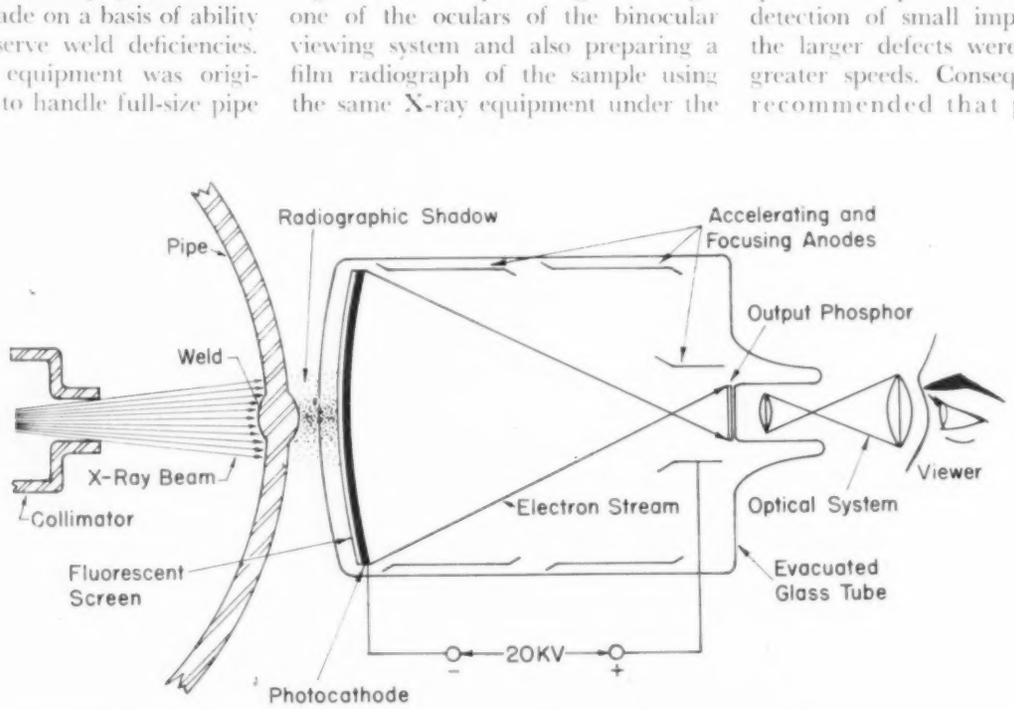


FIGURE 6—Fluoroscopic image intensifier which converts relatively feeble fluoroscopic images on fluorescent input phosphor into an intense image on the output phosphor. X-rays passing through pipe casts shadow image on five-inch diameter screen within the evacuated glass tube. This screen is backed by photo emissive cathode which emits electrons in proportion to the amount of light. High voltages—20 to 25 KV—these electrons are accelerated so they strike the output screen at high velocities, causing the viewing screen to fluoresce in proportion to the intensity of the electron stream. The intensity runs about 1000 times the intensity of the input screen.

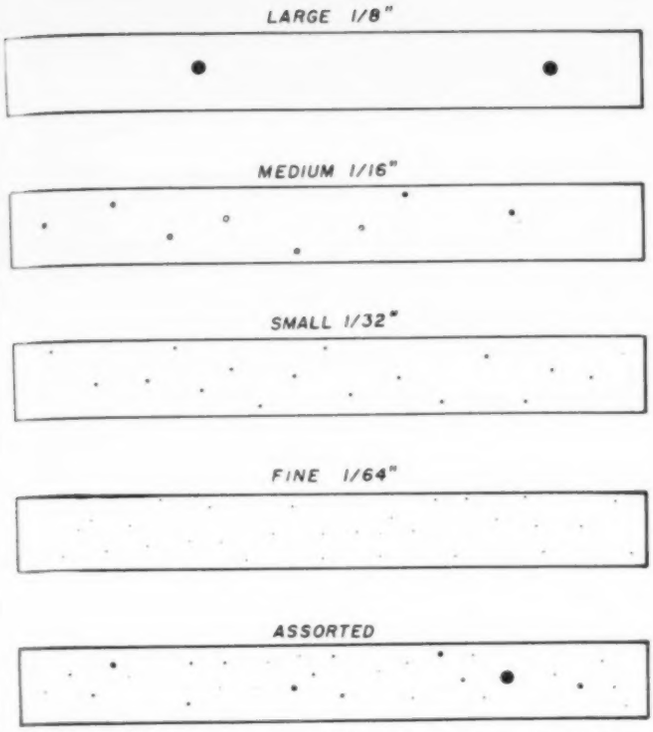


FIGURE 7—Maximum permissible distribution of individual slag inclusions and/or gas pockets in any location.

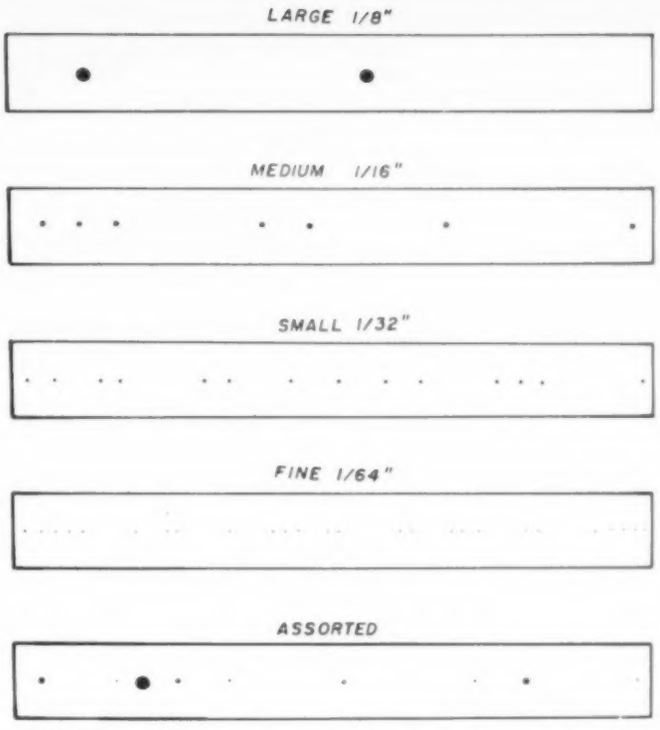


FIGURE 8—Maximum permissible distribution of aligned gas pockets. Final standards will depend on refined techniques.

equipment should be controllable continuously.

Operator capabilities. Prior to operation of this equipment, the entire area was monitored for radiation safety. Readings were taken with the pipe over the X-ray head and also removed. The maximum reading in the lead faced booth with the pipe over X-ray head or removed was zero. Readings in other areas adjacent to the equipment were sufficiently low that special shielding would not be required for a production line installation.

Perception. Although results of this investigation were encouraging, it should be stated that performance depends upon proper training and the development of visual acuity of the operating personnel. Perception is a highly organized activity in which the whole of the observer's organism is involved, and includes such diverse factors as habit, past experience, distractions, comfort, prejudice, nerve impulses from other sense organs—all integrated with the triggering impulses received from the eye. An understanding of these factors is of more than academic interest and should be considered in the design of equipment by which rapid, fine detail discriminations are to be made. Consequently the comfort and convenience of the operator becomes a matter of concern, not from the viewpoint of morale, but as factors that directly affect what the inspector can "see," or more correctly, perceive.

Perceptual training over a relatively short period of time results in a rapid increase in the speed and accuracy of perception. This increase is due to the reorganization and refinement of the entire perceptual process, rather than to a physical change in the observer's vision. The trained observer can see details that are invisible to the untrained observer. On the other hand, an untrained observer can expect his perception to sharpen within a few days to the point where he begins to see details which were at first invisible to him.

The direct binocular viewing instrument was selected because, although it restricts head and bodily movements of the inspector, it gives the impression of viewing the weld at normal reading distance and with greater clarity and brightness than the mirror system. Use of binoculars, however, imposes limitations upon the operator which may prove fatiguing or have an undesirable psychological effect.

It was decided, therefore, to extend the work on this project to explore the possibility of TV as a substitute for binocular viewing. This aspect had been investigated during the work at Battelle with results which were considered unsatisfactory. Equipment and techniques have improved since these trials making further investigation worthwhile.

TV systems. Demonstrations and trials were conducted throughout 1958 in an effort to locate a satisfactory TV system for this application or, at least, develop performance criteria which should be required of a TV system to be used for this purpose. As these trials progressed it became apparent that optics was a major problem, and the results of the evaluation were that in comparison with the image intensifier using binoculars the TV brightness was considerably better, the contrast essentially equivalent, and the resolution not as satisfactory.

Considering the results obtained and the inherent flexibility of using either binocular or TV viewing, the binocular type instrument was selected for the production unit rather than the newly developed image intensifier using only a TV camera.

Production unit. The fluoroscopic inspection unit was installed in the line of production between the expander and end facers at National

FLUOROSCOPIC STANDARD FOR MILL CONTROL OF WELD QUALITY

1. A weld with cracks shall not be acceptable.

2. A weld which lacks complete penetration shall not be acceptable.

3. A weld which lacks complete fusion shall not be acceptable.

4. The maximum dimensions of a single slag inclusion or gas pocket shall not be greater than ⅛ in., except that an elongated inclusion may be ½ in. in length but not more than 1/16 in. in any other direction.

5. The total length of the slag inclusions and/or gas pockets in a 12-in. length of weld shall not exceed 1 in. except as further restricted under item 7 or 8, and the total length of elongated slag inclusions may be 2 in.

6. The maximum distribution of slag inclusions and/or gas pockets which are not elongated shall not exceed that shown in Fig. 5 which is based on the following conditions:
   LARGE—⅛ in. maximum size
   2 discontinuities in 6 in.—minimum distance apart, 2 in.
   MEDIUM—1/16 in. maximum size
   8 discontinuities in 6 in.—minimum distance apart, ¼ in.
   SMALL—1/32 in. maximum size
   16 discontinuities in 6 in.—minimum distance apart, ⅛ in.
   FINE—1/64 in. maximum size
   32 discontinuities in 6 in.—minimum distance apart, 1/16 in.
   ASSORTED—⅛ in. maximum size
   1—⅛-in., 4—1/16-in. 8—1/32-in., and 16—1/64-in., or a total of 29 discontinuities in 6 in.—minimum distance apart, ⅛ in.

7. Any group of gas pockets which are in line shall not exceed the maximum distribution shown in Fig. 6 which is based on the following conditions:
   LARGE—⅛ in. maximum size
   2 discontinuities in 6 in.—minimum distance apart, 2 in.
   2 in any 3 in.
   MEDIUM—1/16 in. maximum size
   8 discontinuities in 6 in.—minimum distance apart, ¼ in.
   3 in any 2 in.
   SMALL—1/32 in. maximum size
   14 discontinuities in 6 in.—minimum distance apart, ⅛ in.
   4 in any 1½ in.
   FINE—1/64 in. maximum size
   26 discontinuities in 6 in.—minimum distance apart, 1/16 in.
   5 in any 1 in.
   ASSORTED—⅛ in. maximum size
   1—⅛ in., 2—1/16 in., 2—1/32 in., 3—1/64 in., or a total of 8 discontinuities in 6 in.—minimum distance apart, ⅛ in.—4 in any 1½ in.

Tube's McKeesport plant. This production unit was placed in operation during January, 1959. Provisions were made to continue conventional X-ray inspection for control purposes during the initial operating phases of the fluoroscope. A schematic arrangement of the production unit is shown in the accompanying drawing. The production rate of this unit is 20 pieces per hour of 24 to 36 inch O.D. pipe 40 feet in length.

The X-ray head is mounted on the end of a boom which in the production installation is 48 feet long. It has stiffening ribs for extra rigidity and contains the high tension cable and cooling water lines for the X-ray head. The center line of the window in the X-ray tube is precisely aligned with the center line of the image intensifier mounted in the inspection booth. The common center line of the image intensifier and X-ray head coincides with a radius of the pipe at an angle of 35 degrees from the horizontal. This arrangement provides natural position for the operator when using the binoculars. Precise alignment of the image intensifier, pipe, and X-ray head is considered essential for maximum response to fine defects such as lack of penetration, fine aligned gas, and cracks.

To maintain the required geometric relationship between the X-ray head, pipe and image intensifier, the pipe carriage height is adjustable so that the same center line may be maintained for all pipe sizes and both the X-ray head and image intensifier are adjustable along their common axes. This arrangement permits maintenance of optimum source—object and object-screen distances for the various pipe sizes.

Basic carriage design is similar to that used in the experimental unit. Riding on rails in a pit adjacent to the front of the inspection booth, the carriage is powered by a fluid motor which drives a pinion geared to a fixed rack on the floor between the rails. Hydraulic power is supplied by a reversible, variable delivery pump. The direction and rate of flow of the pump may be controlled by a "joy stick" in the booth affording smooth and continuous control of carriage speed and direction from 0 to 234 fpm.

Pipe rolls onto the carriage from an inlet table and is lowered onto rubber rollers which support the pipe during the inspection cycle. These rolls are driven by fluid motors: one for clockwise rotation and the other for counterclockwise rotation. Push-button controls in the booth allow the operator to rapidly position the weld between the X-ray head and image intensifier. Proper weld position may be ascertained by viewing the fluoroscopic image as the pipe is being moved over the boom prior to inspection. The pipe is inspected during the return of the carriage.

A paint spray gun is used to indicate the location of defective areas. When inspection is completed the operator depresses the carriage kick-out button in the booth and the pipe is ejected. When the kick-out arms return to their lowered position, the easy-down arms automatically raise to the position to accept the next pipe.

The production unit at National Works is in the experimental stage and therefore an attempt will not be made at this time to present the quality level of inspection which may be obtained on this unit. In this production unit experimental work is being conducted in the development of TV viewing. This, therefore, is a progress report of fluoroscopic inspection work on submerged arc welded line pipe. When additional data has been developed on the production unit, results will be made available. It may be necessary, for example, to modify the present TV equipment in order to secure the desired quality level of inspection. However, with the use of binoculars the present TV equipment should be satisfactory.

Fluoroscopic standards for mill control of weld quality. Tentative acceptance standards[3] for double submerged arc welded line pipe are presented in Table 1 and illustrated in Figures 7 and 8. Acceptance standards will depend on the fluoroscopic technique which has not been completely established. In standard radiographic techniques a defect of a size equal to or greater than 2 percent of the thickness of the pipe wall is usually speci-

Continued on Page 43

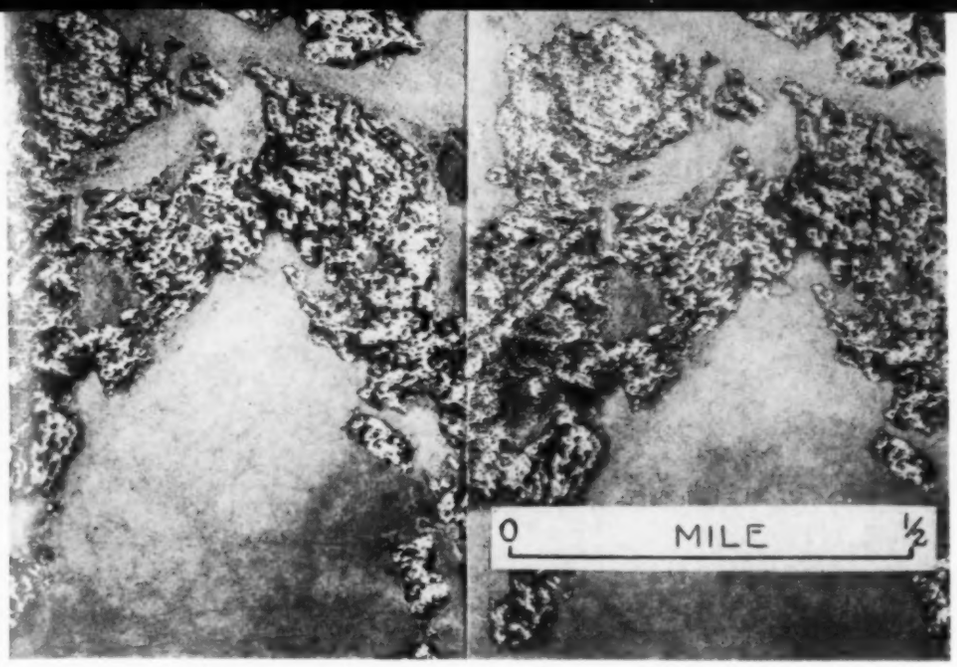
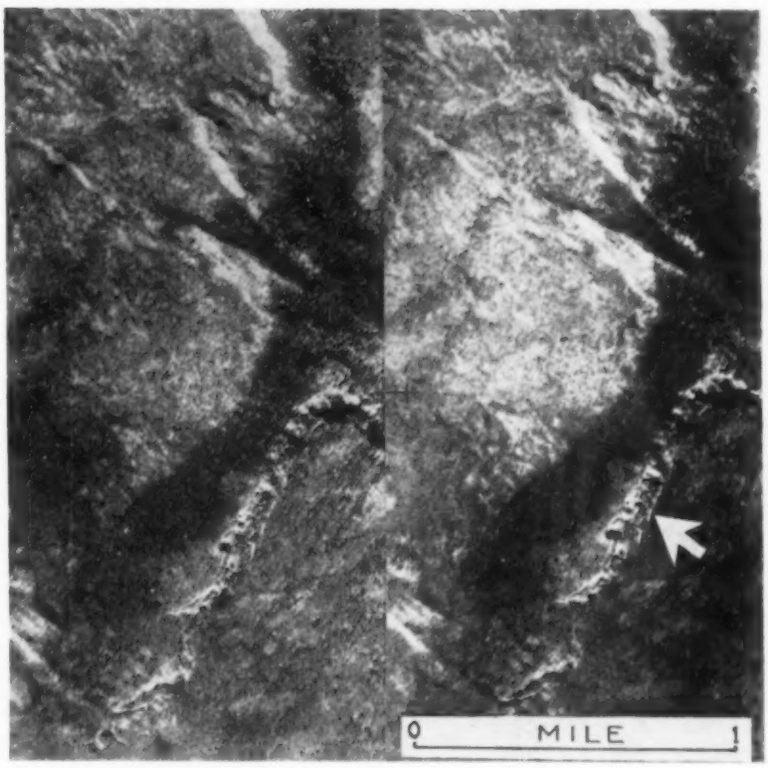


FIGURE 2 (below)—The unusual looking sharp depression, (arrow) seen in this stereopair, has been caused by the solution of soluble bedrock (probably gypsum) below a deep overburden mantle of unconsolidated fine sands. Evidence of active solution beneath the surficial sands manifests itself initially as small individual cone-shaped pits. In time, the pits enlarge in size and coalesce to form a continuous trench. Where pipe lines must of necessity cross these sharp V-shaped depressions, it is well to appreciate their origin and significance. Note the high sand dune ridges in the upper right corner of this stereopair.

FIGURE 1 (above)—An example of Precambrian Shield terrain. The area consists of essentially bare hard rock surrounded by deep open muskeg. For the most part, slopes surrounding bedrock islands are precipitous. Cross-country pipe line construction is expensive in this country where mineral soils are nonexistent. From the photos, however, separation of the two basic terrain types is very easy.



How to Use Aerial Photos In Pipelining

There's more to interpreting than just spotting hills and gullies. These photos show additional hazards and important information

By **J. D. Mollard**

J. D. Mollard and Associates, Ltd.
Regina, Saskatchewan

MUCH HAS BEEN written in the last 10 years on the identification of soil and bedrock types using aerial photos. In addition to local topographic irregularities and surface drainage conditions, a good deal can be told about the composition and condition of the surficial materials. Under certain circumstances, a fairly reliable estimate can be made as to whether or not bedrock will be encountered in the trench to be excavated.

Following are some of the features that normally require recognition and evaluation, especially where alternate competitive routes or competitive portions of routes are indicated from the aerial photos:

1. Potentially unstable slope conditions along the line—such as areas of active subsurface solution (Figure 2); areas of large-scale slope creep; former landslides or slumps that may be reactivated (Figure 3); and the sites of earthflows and snow and debris avalanches (Figure 4).

2. River crossings—e.g., width of open water; steepness of nearby valley sideslopes; whether a river is actively aggrading, downcutting or essentially at equilibrium (Figure 5).

3. **Slopes so steep that they necessitate difficult and costly construction** (Figures 1 and 2).

4. **Hard rock excavation** (Figure 1) and dense boulder concentrations (Figure 6).

5. **Places where the pipe may be exposed**—for example, in areas of actively shifting sand dunes (Figure 7). These are also places where travel by wheeled vehicles used in "stringing" pipe along a spread becomes more difficult (6).

6. **Numerous lakes and smaller water-filled rock basins.**

7. **Deep floating bogs, marsh and swamp.**

8. **Permafrost and related frost-action phenomena.**

9. **Marked variations in the salt content of soils.** This problem is no longer so troublesome in the case of pipe lines used for transporting natural gas, crude oil and other petroleum products because cathodic protection and pipe line coating and wrapping are now standard practice. But in arid and semiarid areas the airphoto identification of high salt-concentration sites is still a consideration where untreated steel pipe lines are used for water supply and in sewer installation.

Where unfavorable terrain cannot be avoided for one reason or another, the location of the affected area is pinpointed and its areal extent and natural setting determined so that subsequent field examination and subsurface testing, if necessary, can be concentrated at these places. In inaccessible country these areas may advantageously be visited initially by helicopter.

FIGURE 3—Note the "broken" angular slump topography in the lower right corner of this photo, between the river's edge and the railway line. Along the sides of present-day river valleys and large former glacial spillways in many areas of Western Canada, large-scale slumping and creep phenomena are commonplace. Some of these slopes have become stabilized; yet others clearly have not. Areas of wholesale slumping in the past are repeatedly reactivated at places where lateral river erosion takes place at the toe of slope—such as at the slope failure location recorded here.

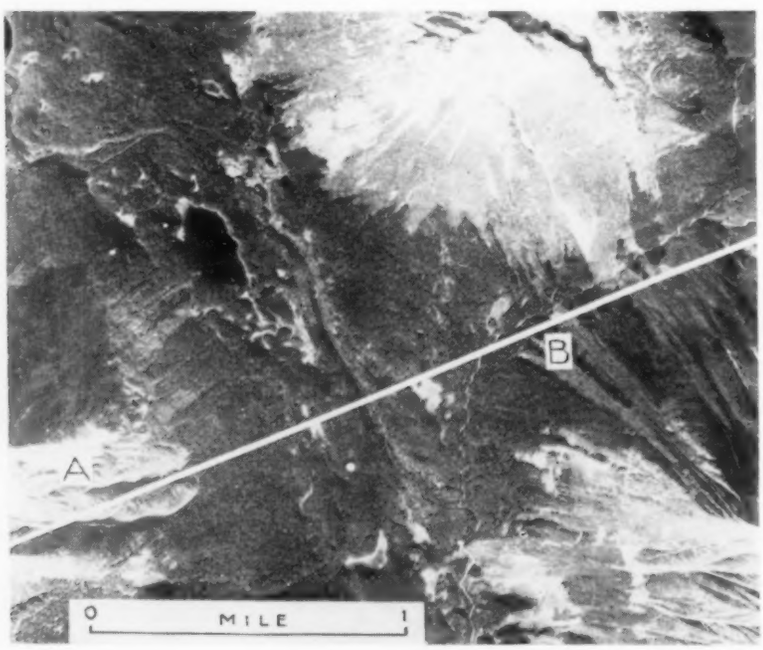


FIGURE 4—Trans-mountain pipe line location invariably poses a variety of engineering and construction problems. In addition to topogrophic problems and streambed crossings in the mountains, debris, snow avalanches and rockfall must be considered as well as indications of slow and rapid earthflows. Two slope instability conditions that might damage the hypothetical pipe line shown in this area (see the straight white line) are the earthflow at "A" and a debris avalanche at "B." At "B," debris-avalanche materials during descent have stripped off the native tree cover. Here again the question arises: Is it possible to circumvent these problem areas without sacrificing other desirable features of the projected line? The answer lies in a regional examination—first from aerial reconnaissance, then from mosaic study followed with stereoscopic examination of contact prints, and finally, ground study. Conceivably the mosiac study may even precede the aerial reconnaissance flight.

Present Land-Use Considerations. Even where natural obstacles adversely affecting pipe line location are rare photos are still valuable. They expedite the accurate location of farmsteads and property lines. In built-up areas surrounding cities, suitably scaled mosaics prepared from recent photography show the general type and arrangement of buildings as well as the character of urban land-use. As a matter of fact, greater use is often made of aerial photographs in areas of highland-use intensity than in remote areas where natural terrain obstacles are more common.

Other Applications of the Interpreted Airphoto

Helping to set up contracts on a uniform basis. It is true that in terms of construction time required and money spent on trench excavation, one mile of difficult construction may be the equivalent to 5 miles of so-called "easy going." The analyzed airphoto may therefore assist in setting up contracts in such a way that adjoining contracts may be completed more or less at the same time and on schedule.

Locating concrete aggregate sources. Aggregate supplies for con-

crete construction used on the job may be located from airphotos. Today this practice is commonplace. A large group of papers deal with this particular facet of photo-interpretation. Concrete aggregates may be required in the construction of pumping stations and for weighing pipe in areas of marsh, swamp and open water.

Dividing the route into topographic classes insofar as these affect length of pipe to order in advance of actual construction. Where a projected pipe line covers a fairly long distance—say 1,000 to 2,000 miles—local topographic irregularities often vary materially from region to region along the line. An increase in plan length is then necessary to account for the "ups and downs." (Figure 8.) This factor can be an important item if total pipe requirements must be purchased in advance of the time construction operations actually begin.

Finalizing as much location as possible before field survey work commences. Airphotos coupled with available relevant terrain maps, highway maps and spot ground checks at key-information localities often permit pipe line location studies to proceed without alerting property owners.

In addition to these applications, contact photos and mosaics are used by survey party chiefs in planning and implementing their field operations.

Use of Aircraft and Helicopters. Aerial reconnaissance and photo interpretation studies may effectively complement each other.

The observer in an aircraft usually views a constantly changing scene, not a stationary one. He gains a fleeting impression. Even so, such a flight may be all that is needed. Also, this flight is most helpful when the observer has a small-scale mosaic in front of him. With mosaics at hand the aerial observer can identify his position accurately and, in addition, make cursory notes.

Helicopter and/or light aircraft flights over a route before and after stereoscopic airphoto examination of the terrain will usually yield optimum data for planning and locating pipe lines. This is especially true where a projected pipe line location crosses a complex association of favorable and unfavorable terrain occurring in essentially inaccessible country.

FIGURE 5—This illustration, actually a small-scale mosaic, shows the disposition and areal extent of large slump areas along the South Saskatchewan River in Saskatchewan, Canada. Large tracts (see scale bar) of slump topography occur intermittently along the valley sides at areas designated A, B, C, D and E. A favorable pipe line crossing is seen in the immediate vicinity of the dashed line, X-X, between slump areas D and E. Here valley side slopes are gentle and the river channel itself is comparatively narrow. Valley sides also appear stable, showing no signs of former instability. Note also the large sand bar on the east side of the river at this location. Long black arrows point to reaches of bank undercutting by the river.

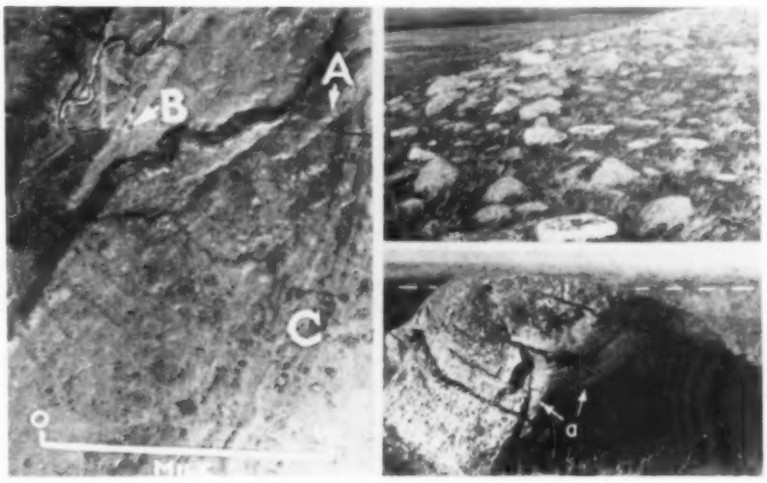


FIGURE 6—The airphoto on the left reveals a landscape strewn with dense concentrations of large glacial boulders. "A" points to a ridge of particularly dense boulders (upper right); "B" points to an individual boulder weighing several tens of tons. Letter "C" is situated in an area of these moat-surrounded giant boulders. Polished corners ("a," lower right) are variously attributed to buffalo or to the blasting effect of sand-laden winds. Large tracts of these dense near-surface boulders are usually confined to long narrow belts adjoining former meltwater channels that were downcut in to bouldery glacial till. In parts of Southern Saskatchewan the lateral displacement of a pipe line location of as little as 1,000 feet will sometimes shift construction operations from 20 miles of trenching in densely concentrated large boulders into 20 miles of trenching in essentially boulder-free terrain.

Conclusions. Both the value and limitations of photo-interpretation terrain studies are governed to a very large extent by the experience and background training of the aerial observer.

Photo interpretation is seldom expected to stand alone. Some sort of

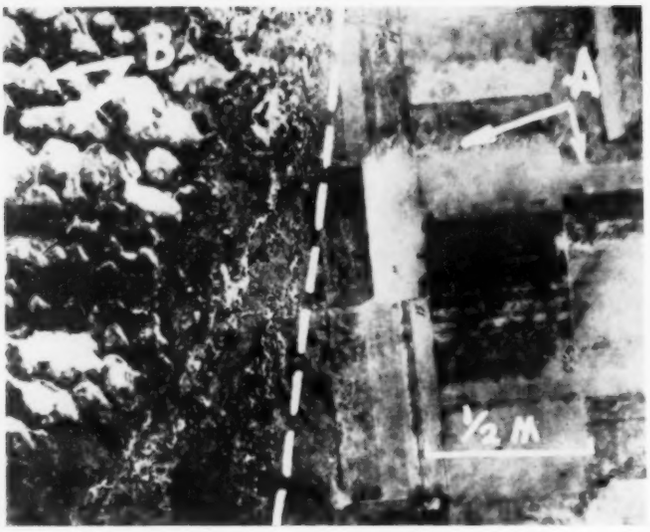


FIGURE 7—The area on the right is a nearly level plain underlain by fine sand; the landform on the left consists of unvegetated sand dunes subject to strong wind action. "A" points to evidence of soil drifting on cultivated fields; "B", to exposed sand dunes with little or no vegetative cover.

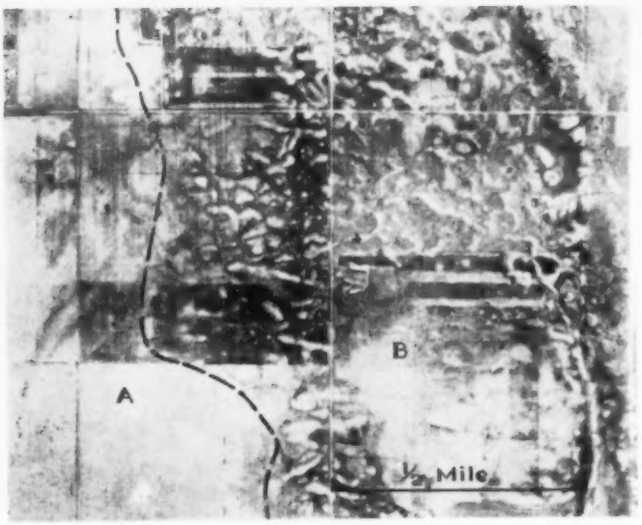


FIGURE 8—This illustration demonstrates differences in topographic form that affect the total length of pipe required. Area "A" is essentially a level plain while area "B" reveals a pronounced hummocky knob-and-kettle landscape, so common on the prairies. Light tones are associated with the tops of sheet-eroded knolls and ridges, many of which are 20 to 50 feet high.

associated field work is almost always required.

Terrain appreciation studies from airphotos are flexible because they can be tailored to requirements of the individual job and to the budget of the job being investigated, small or large. Moreover, air photo studies are not held up by poor weather or by delays associated with trespassing over private property.

No area is too remote or too inaccessible to receive proper attention by the airphoto analyst. Probably the most important factor in terrain appreciation from airphotos is the 100 percent blanket cover.

Photo interpretation is no panacea to pipe line location problems. Just like any other tool or technique, it must be used with common sense and used whenever and wherever it is the best means available for attaining a particular objective.

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About the Author

John D. Mollard has devoted nearly 15 years to research and field studies in aerial surveying and photo analysis. After graduation from the University of Saskatchewan with a B.S. degree in civil engineering, he worked with the provincial Department of Highways. He then attended Purdue University, receiving a Master's degree in 1947. Following three years work as Air Surveys Engineer he studied at Cornell University and received a Ph.D. in engineering in 1953. Mollard's work since completion of academic studies has included photo interpretation research on loan to the U.S. Armed Forces on beach accessibility and cross-country travel conditions in inaccessible terrain; consulting on aerial surveys in West Pakistan and Ceylon; plus photo surveys for geological, pipe line, dam construction, irrigation and water development, and a variety of purposes. He has written a number of papers on this subject for presentation to engineering groups and in technical publications.

ACKNOWLEDGMENT

Acknowledgment is hereby given to the following for the air-photos reproduced with this article: RCAF Photographs—Figures 1, 2, 3, 7 and 8. Also for left hand portion of Figure 6. Figure 4 is a mosaic prepared from RCAF photographs. British Columbia Government Photograph—Fig. 4

Comparing Calculated Flow With Actual Pipe Line Flow

Theoretical versus practical values on the Le Havre-to-Paris products line

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THE ENGINEERING of any new pipe line system centers first around the determination of head loss. This is the fundamental design factor so far as products and crude lines are concerned; it is the basis for estimating pipe size, station size, wall thickness of pipe and operating costs. *Yet the pipe line industry does not have a truly accurate formula for calculating these values!*

Experimental work carried out at France's National Hydraulic Laboratory at Chatou, France, and on the Le Havre-to-Paris products line shows that rational flow formulas—such as they are today—should be rejected in favor of tables and curves derived from Colebrooks results published in 1939.[2] In addition, these experiments indicate that a relative rugosity of 0.0002 tending toward 0.0001 are applicable where refined products are concerned. The curves of the Hydraulic Institute established a relative rugosity of 0.0002 for new pipe lines with a reduction being obtainable during operations—as the roughness factor diminishes.

A third finding based on experimental work indicates that the coefficient "C" of Hazen and Williams' formula can be used to survey rugosity during the course of operations. It should be noted however, that it is not valid except under certain operating conditions. For each particular case, an attempt can be made to establish an improved formula with new exponents that would better apply.

Results of Theoretical Experiments. Research workers have directed their efforts toward establishing a coefficient of friction which itself is a function of the Reynolds number, R and the relative rugosity, $\frac{\varepsilon}{D}$

The leading experimenters in this field were:

Nikuradse, who experimented on tubes that were given a theoretical rugosity obtained by sticking round grains of sand of appreciably uniform diameter to the sides of the internal polished walls.

Colebrook and White who experimented on tubes having a rugosity more closely resembling the practical conditions of commercial lines, obtained by using grains of sand of non-uniform diameter.

Nikuradse's experiments led to tracing of curves giving the coefficient of friction λ in relation to the Reynolds number "R" for each relative rugosity.

For very small Reynolds numbers, flow is laminar and the curve Log $\lambda = f(\log R)$ is the straight line that explains Poiseuille's law $\lambda = 64\,R^{-1}$.

The transient period between laminar and turbulent flows is produced in the neighborhood of R = 2,000. This being established, experimental points are aligned along a straight line corresponding to Blasius' formula: $\lambda = 0.3164\,R^{-0.25}$ for a range of Reynolds numbers all the more extensive as the pipe surface is smooth.

Starting from a critical point corresponding to Rc, the experimental points become detached from Blasius' straight line, and after a new transient period—that ends when the Reynolds number attains a second critical point R'c—the points are found on a straight line: log λ is a constant, charactertistic of the relative rugosity of the line.

Where R > R'c flow is in the so-called "turbulent rugose" range. Nikuradse has proposed the following formula for λ independent of R:

$$\frac{1}{\sqrt{\lambda}} = 2 \log 3.7 \frac{D}{\varepsilon}$$

All Nikuradse's curves are reproduced on Figure 1.

Results obtained by Colebrook and White have broadly confirmed those of Nikuradse by specifying that the divergence between Rc and R'c is more extensive than that found by Nikuradse.

In place of Blasius' straight line or Von Karman's curve, Colebrook and White have proposed the curve corresponding to the following formula:

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{2.51}{R\sqrt{\lambda}} \right)$$

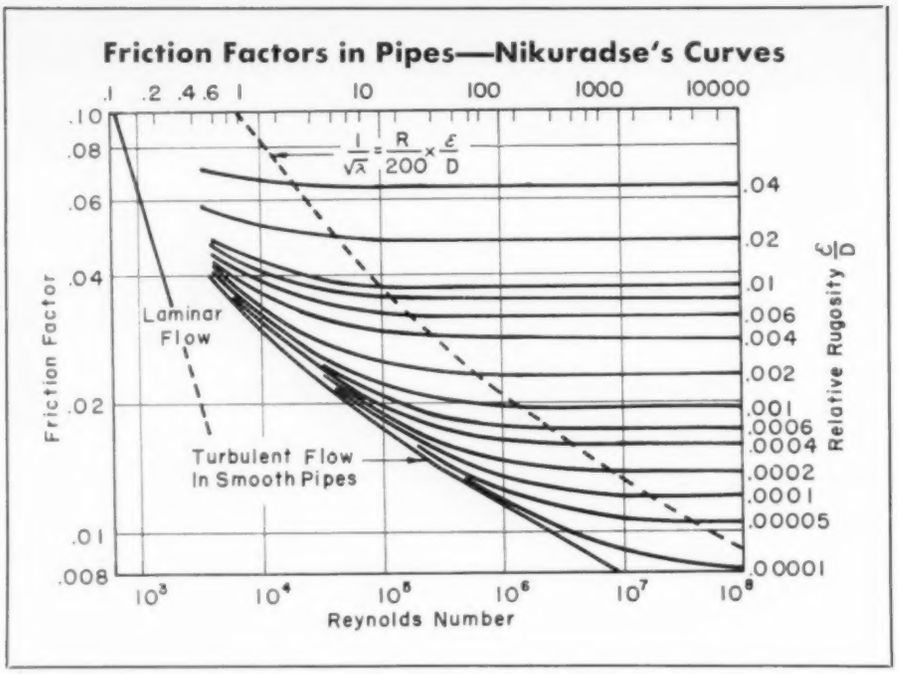

FIGURE 1

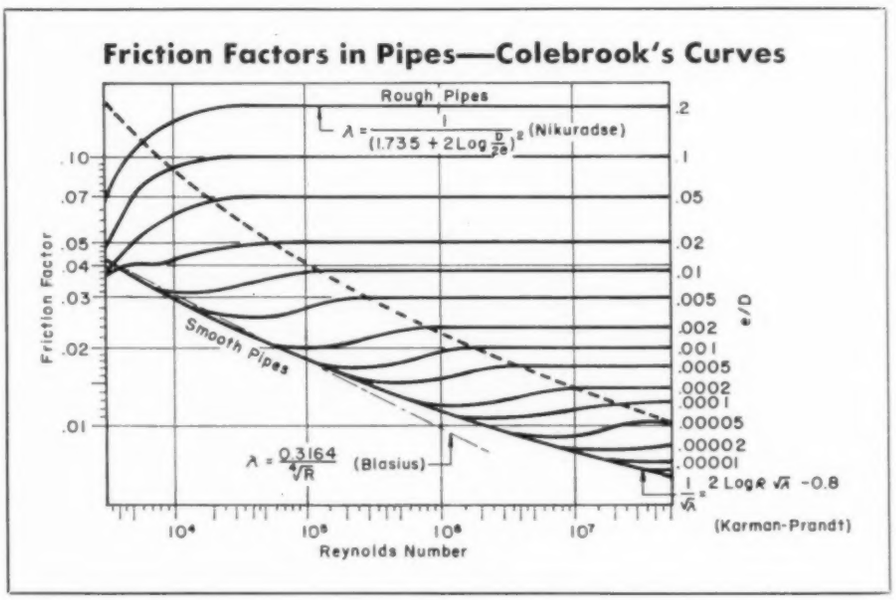

FIGURE 2

which is identical to Von Karman's curve for smooth tubes.

In addition, Moody has proposed as a curve giving λ in relation to R'c, corresponding to the equation:

$$\frac{1}{\sqrt{\lambda}} = \frac{R'c}{200} \frac{\varepsilon}{D}$$

This curve limits the zone to the straight line of which the coefficient of friction depends only on the relative rugosity.

In the case of loss of head in pipe lines, these foregoing ideas have no more than a theoretical interest, for, in practice, we always find ourselves between points Rc and R'c.

Experiments on commercial tubes, carried out by other experimenters, but studied by Colebrook, have enabled the later to admit that these tubes have behaved in very much the same way as the artificially rugosed tubes of Colebrook and White. The average roughness of steel tubes has been found to be 42 microns.

The fundamental difference between the curves of Nikuradse and those of Colebrook for the transient period is shown in Figure 3.

Other experimenters who have a great importance in the practical field of losses of head calculations are Stanton, Pannel and Pigott. The work of Stanton and Pannel is particularly important, because a certain number of formulas and curves used in the United States for the pipe line projects come from these experiments carried out in 1913; those tests give results roughly consistent with those of Colebrook and White's curves, but the values of the friction factor have not been worked out for a scope corresponding to the one of commercial pipe lines.

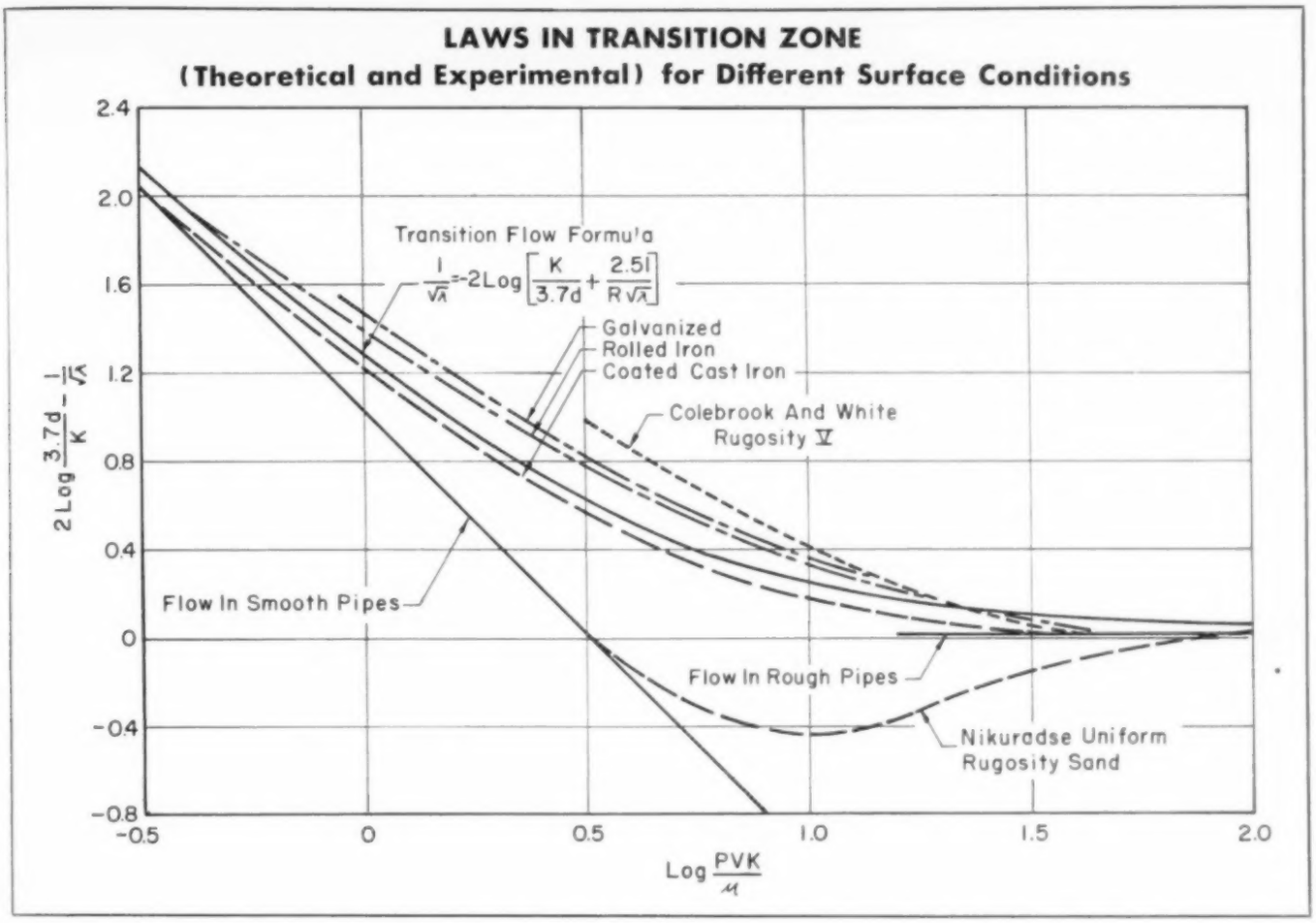

FIGURE 3

Certain experiments of Stanton and Pannel were carried out on larger diameters that approached practical diameters but for low Reynolds numbers.

The comparison of this formula with Hydraulic Institute work calls for the following conclusions:

- It corresponds to the perfectly smooth tubes of the Hydraulic Institute curves,
- Consequently it gives results slightly lower than those of the Hydraulic Institute,
- For medium Reynolds numbers (crude oil lines) this divergence is small; the larger the diameter the smaller the divergence (almost negligible from 30 inches),
- For medium diameters, the Hydraulic Institute values correspond fairly well with the newly-welded pipe lines. Stanton and Pannel compare with the pipes after "running in," i.e., after an unceasing service of several years.

Work of the Hydraulic Institute. Colebrook and White's work was used for editing the Standards of the Hydraulic Institute, which includes the following basic documents:

1. The average dimension of roughness for each type of tube was fixed (steel, cast iron, copper, glass, etc. . . .). For current seamless steel tubes,, for example, the dimension of average roughness was fixed at about 50 microns. A relative rugosity per diameter was deduced from it.

2. The coefficient of friction in relation to the Reynolds number. Colebrook and White's curves are traced at the rate of one curve per diameter. The Hydraulic Institute's curves are therefore Colebrook and White's curves with an average dimension of roughness taken as equal to 50 microns.

Various Empirical Formulas. The use of curves has appeared somewhat impractical to anyone who has attempted to replace Colebrook's curves by formulas more or less approximate. In general, the idea has been to replace these curves by straight lines in doubly logarithmic coordinates. It has thus been proposed:

by Hetzel's formula: $f = \frac{0.364}{R^{0.265}}$

for "R" contained between 3000 and 57,600.

Kennedy's revision: $f = \frac{0.3305}{R^{0.265}}$

for "R" contained between 6000 and 170,000.

O'Brien's revision: $f = \frac{0.259}{R^{0.23}}$

for "R" contained between 7000 and 200,000.

These formulas thus enable the direct calculation of loss of head without having recourse to the curves of the Hydraulic Institute. The most widely used of these formulas is that of Hazen and Williams, which was established for water, but is absolutely valid for light refined petroleum products.

It will be recalled that this formula is written as follows:

$$h^{54} = \frac{K}{C}\,\frac{Q}{D^{2.63}}$$

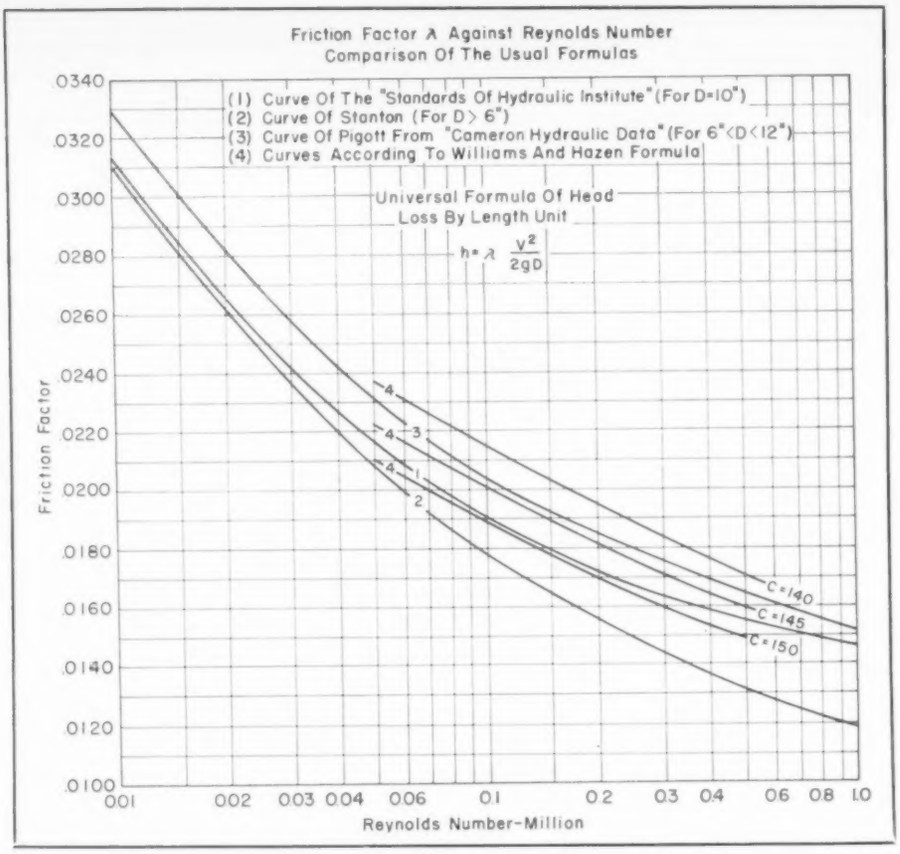

FIGURE 4

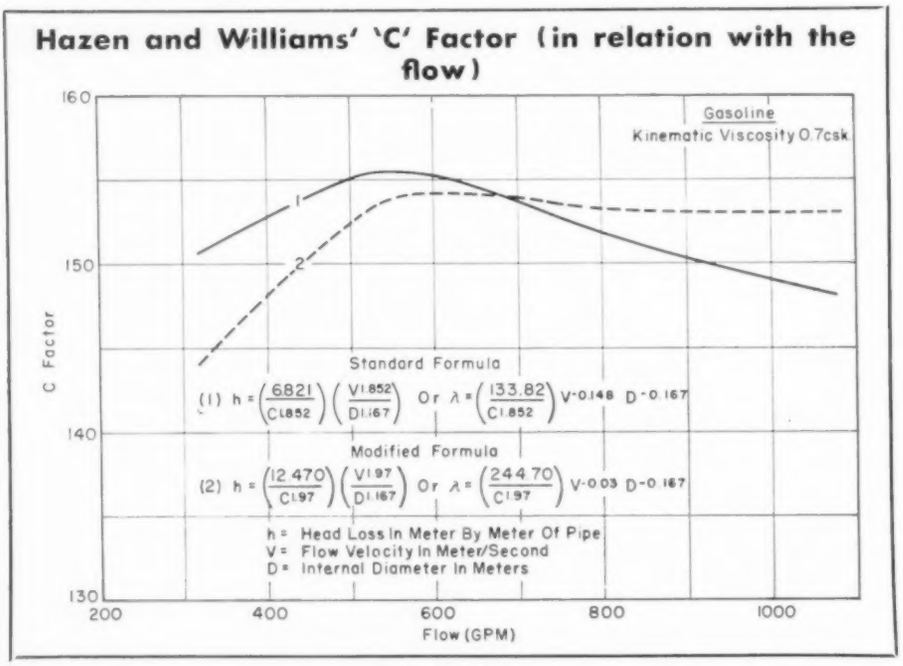

FIGURE 5

About the Author

J. B. Capdeville is a graduate of the Polytechnical School of Paris, France, and started his career in the Citroen automobile plants which pioneered the mass production of automobiles in France. In 1939 he was appointed assistant to the chief engineer of the French subsidiary of the Anglo-Iranian Co. After World War II he was commissioned by the French government to study pipe line techniques in the United States. He was director of operations of the T.R.A.P.I.L. Co. which operates the Le Havre-Paris and military refined products pipe lines in France. In 1956 he was appointed assistant general director of the company.

where "C" is a coefficient depending on the coefficient of friction.

If we try to put it under the general form:

$$h = \lambda \frac{V^2}{2gd}$$

we obtain, at the expense of a slight approximation:

$$\lambda = \frac{K_1}{C^{1.85}} \cdot (VD)^{-0.16}$$

That is to say λ is thus in the form of the preceding formula if a constant density and viscosity is admitted, which, practically, is the case for gasolines.

"C" then depends solely on the rugosity of the inner walls of the tube. Its value is from 140 to 150 for a current seamless steel tube. As long as the inclination of the tangent to the curve λ in logarithmic coordinates is appreciably equal to 0.16, the coefficient "C" scarcely varies with the flow rate.

Comparison of Various Formulas. As a result of the variety of diameters used in pipe lines and the extensive range of products with viscosities varying from 20 to 0.5 centistokes, the hydraulic state of pipe lines corresponds to large Reynolds numbers varying from: 20,000 to 250,000 for crude oil, and 200,000 to 1,500,000 for refined products.

This means to say that simplifying formulas, no matter what they be, should be used with the greatest prudence.

Figure 4 gives the comparison of some coefficient of friction curves in relation to the Reynolds number. It will be seen that only Hazen and Williams' formula, with C = 150, approaches closely the curve of the Hydraulic Institute for Reynolds numbers contained between 70,000 and 500,000.

This formula is therefore more or less valid for the zone in question. However, it does not cover flow where the Reynolds number ranges on up to 1,500,000 as indicated above. Hazen and Williams' formula, however, has the advantage of producing a coefficient "C" easy to calculate and use in the survey of rugosity during the period of operations.

Experiments Carried Out at The National Hydraulic Laboratory at Chatou. The object of the experi-

ment was to determine the loss of head coefficient in 10-inch pipe within a range of determined flow rates—ranging from 1,100 to 1,700 barrels per hour.

Experiments carried out with water are evidently sufficient for loss of head studies, since, for determined flow rates, the curve (coefficient of friction in relation to the Reynolds number) for gasoline is deduced from the curve for water by multiplying the abscissae by the ratio of the viscosities and the ordinates by the square of the ratio of the viscosities.

Experiments were conducted at the Chatou laboratory under the following conditions:

1. Twelve tubes originating from two different lots (internal diameter: Lot No. 1: 238, Lot No. 2: 240), of a total length of 90 meters, were welded together to form a whole comparable to real conditions.

2. These tubes were fed with water from a constant level tank through a honeycombed tranquilizer.

3. Flow rate measurements were taken by an overflow device with thin walls. Pressure was measured with 12 water manometers distributed along the tube.

Corrections of measured loss of head were adjusted to take into account: (a) the transposition from water to gasoline that would be effected as indicated above; (b) the diameters that were not strictly equal between them; a hydraulically equivalent diameter of 239.7 millimeters was calculated; (c) finally, two different curves were traced for the two lengths, I and II, of tubes for which it was established that the rugosity was not exactly the same.

Results obtained: (a) the points obtained were found to be approximately on the Colebrook curve for a relative rugosity equal to 0.0002, which corresponds exactly to an average roughness of 50 microns—or that adopted by the curves of the Hydraulic Institute.

(b) As one would expect, the coefficient "C" of Hazen and Williams' formula varies with flow rate in a relatively important way.

(c) Figure 5 gives the variation of the coefficient "C" in relation to the flow rate obtained after experimental trials.

Use of Hazen and Williams' Formula During Operations. Whatever the value is—absolutely relative—of the Hazen and Williams' formula, it nevertheless enables the verification of the internal condition of the line; this is why measurements have enabled the periodical calculations of the coefficient "C" of the said formula during the course of operations on the Le Havre-Paris line.

To carry it out, loss of head was measured as carefully as possible during a period when the tube was full of gasoline and when the hourly flow rate was practically constant. As it has been observed above, however, the coefficient "C" varies in an important way with hourly flow rate, and it became apparent that the classic Hazen and Williams' formula could not validly be applied to all working conditions. We find various exponents amongst different authors, but based on the preceding, a slightly different formula was established that gave a coefficient varying but slightly with a flow rate—for hourly flow rates of 1250 to 1700 Bbls per hour—that could be maintained in the pipe line during a relatively brief period required for each experiment.

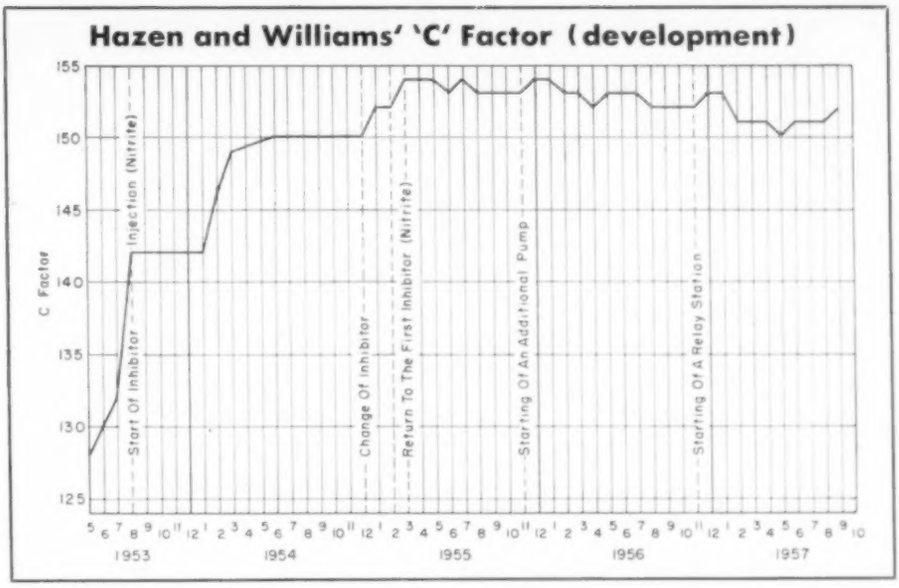

FIGURE 6

Although the classic Hazen and Williams' formula is:

$$h = \frac{6.821}{C^{1.852}} \times \frac{V^{1.852}}{D^{1.167}}$$

the following formula was adopted:

$$\frac{12.47}{C^{1.97}} \times \frac{V^{1.97}}{D^{1.167}}$$

Figure 5 represents the curves of variation of the coefficient "C" relative to each of the two formulas in relation to flow rate.

Whatever they might be, results obtained in operation cannot be presented as absolute for the following reasons:

- It is impossible to maintain a permanent hydraulic state during the few hours required for the measurements;
- Precision of manometers do not carry every guaranty;
- Errors in readings are far from being negligible;
- Viscosity and density are supposed to be constant, which is not necessarily the case.

The results obtained are recapitulated on the curve (Fig. 6) on which figures the coefficient "C" of the classic Hazen and Williams' formula in relation to time.

The following stages can be distinguished on this curve:

(a) At the start of operations, a relatively low coefficient "C" of 128 was ascertained which is explained by the presence of oxides on the internal walls of the tubes resulting from hot lamination. An intensive program of scraper runs raised the value of the coefficient to 142 within a few months.

(b) The coefficient "C" attained a value of 150 at the

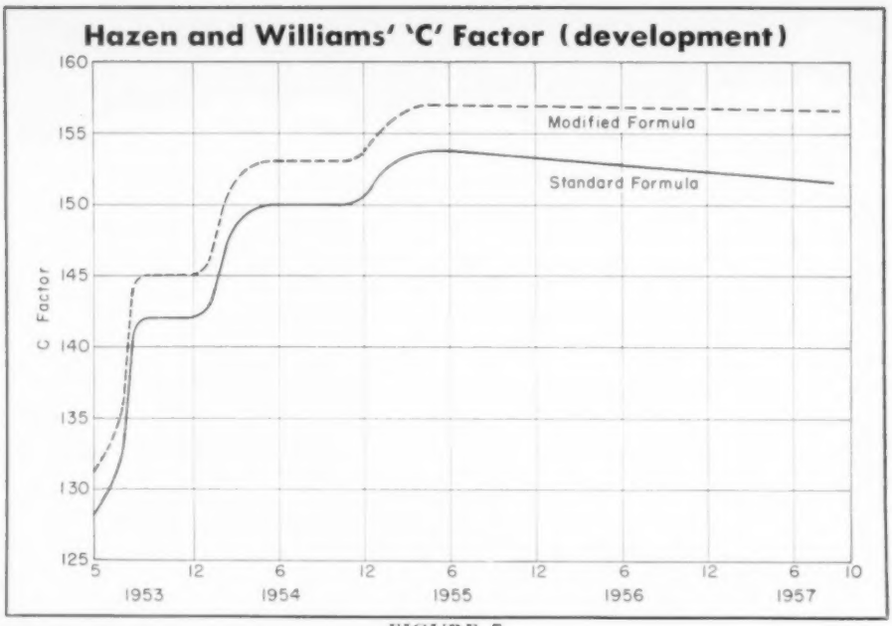

FIGURE 7

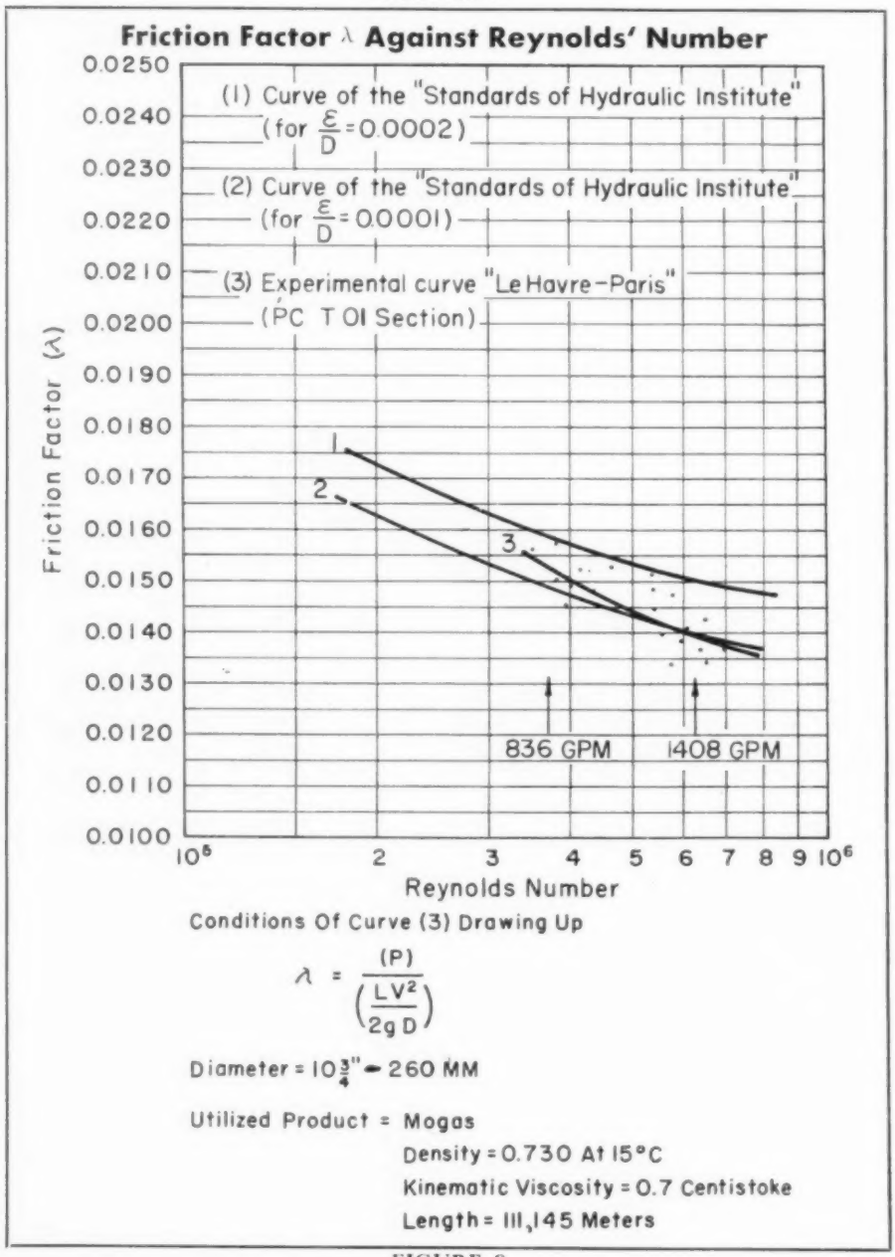

FIGURE 8

end of a year's use of sodium nitrite.

(c) At the end of 1954, the use of an organic inhibitor raised the value to 154.

(d) The coefficient of "C" was maintained between 154 and 152 up to the end of 1956.

(e) Finally, as new stations were brought into operation, thereby increasing the flow rate (end of 1956), there was a drop in the coefficient "C". This drop, however, is related to and comes from the variation of the coefficient "C" in relation to hourly flow rate. If we take into consideration the coefficient "C" of the modified Hazen and Williams' formula, we obtain the simplified curve (Figure 7) which shows that the coefficient "C" and, consequently, the rugosity, are stabilized.

(f) Generally, if an exception is made of the initial cleaning period, it may be stated that inhibition suffices to insure protection of the inner walls as scrapers do not any more reveal oxide deposits. No more modification of the coefficient "C" is observed after scraper runs. Scraper runs have not therefore been maintained except as a supplementary precaution and their frequency has been reduced to about one run per month.

(g) If, in place of coefficient "C", we calculate the coefficient of friction λ for the stabilization period of coefficient "C", a curve of coefficient λ can be traced in relation to the Reynolds number. The curve in Figure 8 is so obtained and it indicates that the experimental curve is found approximately at the level of Buthod's curve (derived from Colebrook and White's results) for a relative rugosity

$$\frac{\varepsilon}{D} = 0.0001$$

It can therefore be concluded that the relative rugosity that was 0.0002 in the beginning (experimental trials at Chatou) progressively attained the value of 0.0001.

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Cut Down Your Employe Turnover Rate

Check over these points to make sure that some of your company policies aren't "driving" employes away

TURNOVER, ALWAYS a problem in industry to some extent, has become a matter of unusual concern today due to the high cost of recruiting and training of technical personnel.

Other costs, such as loss of effective production while the new employe is learning the job, wastage of raw material, expensive accidents, higher insurance rates and other overhead expenses, cannot be ignored either.

Of course, turnover can never be completely eliminated, but excessive rates can be reduced. This reduction is possible only when management becomes aware of the conditions and actions that cause turnover, and when corrective action is taken to alleviate the conditions and change the actions.

Needless to say, management is primarily responsible for the control of turnover. Upon careful analysis, management will find no single cure for this malady, but nevertheless some remedies can be found.

But we are about to get the cart before the horse. Before a doctor recommends a remedy for an illness he ascertains the cause. By the same token, before we latch on to some remedies for turnover, a thorough study of the "causes" is essential.

High turnover. Industrial and academic studies verify the fact that the highest incidence of turnover usually occurs during the first month after hiring. In addition, the turnover rate is higher for young employes than for the older workers.

Below are many conditions and actions that, if present, make it possible for a company to receive the White Elephant Award for the country's highest turnover rate.

1. Poor selection methods. The personnel of the employment office must first understand the job duties and requirements before they can select a worker to fill the vacancy. If they do not have such an understanding it is quite probable that many workers will be assigned to jobs for which they are not suited.

Their physical, mental and technical qualifications must be matched as closely as possible to the job duties and requirements.

If not, the misplacement can cause unrest and dissatisfaction among the new workers. Discouragement follows and the workers quits in the hope of finding a more suitable job with another company.

Remedy: First, the employment interviewer must have a realistic and up-to-date knowledge of the job and its requirements. Inadequate information here will result, many times, in the hiring of under- or overqualified workers.

Next, many measuring devices such as aptitude, interest, and proficiency testing; physical appraisal; personality evaluation; and other techniques can be used. The goal, of course, is to get the right man in the right job.

Such evaluation will help eliminate the possibility of a worker being assigned a job below or above his skill level.

2. Poor working conditions. Poor lighting, inadequate and faulty tools, and dirty and cluttered premises all contribute to turnover. And, especially where women are employed, a lack of proper rest rooms, eating places and lounges will go far toward raising the turnover rate.

Remedy: Provide good working conditions and in-plant facilities and services. When prospective employes are shown around the premises a well-kept house with all necessary living facilities will contribute positively to their decision.

Employes like to feel proud of their working "home." Given encouragement and proper equipment by management they will tend to be happier and more content with their jobs. This, of course, is a deterrent to turnover.

3. No opportunity to advance. Staying too long on one job will cause a worker to complain and look about for a solution. Seeing no chance for advancement or change he will go "job shopping" during lunch hour and over week-ends.

A survey of college graduates revealed that opportunity for advancement was the number one reason for selecting a particular company. Therefore, when such opportunity does not present itself, the employe will change companies.

Remedy: Never tell a prospective employe, when he asks, that he will advance if he works hard and "keeps his nose clean." This is just another way of saying that your company has no well-defined system of promotion or transfer.

To remedy the situation an employe appraisal plan should be formulated. Based upon this appraisal, along with seniority and other rights, a clear-cut, workable system can be devised for promotion.

Such a plan should be explained to the new employe. Where the job has no real future for advancement, a full explanation should be given the applicant before he is hired.

A word of caution. An overqualified, ambitious applicant may state that he is willing to take the job and will be satisfied, "Just as long as I can work for your company." Don't be deceived. He will more than likely become dissatisfied and either quit as soon as he has found another job or become a complaining, troublesome worker.

The better course is to put a "brave" in the job in the first place and send the "chief" on his way to find a suitable job with another company.

4. Hiring all "chiefs." The writer recalls a statement made by a novice in the hiring field which postulated the hiring of only the top ten percent of all applicants. Every job would be filled with highly intelligent, highly qualified employes.

His idea was to have a "super" company much like Hitler's "super" race. Of course, such a plan would never work. Instead of a "super" company, he would have a disgruntled, griping and dissatisfied company. Some "braves" are well needed to do the jobs that do not require leadership or "chief" qualifications.

Remedy: It is much safer to match the abilities and interests of the new employe to the job duties and qualifications. Employes of all intellectual levels (that is, above the feeble-minded level—and sometimes one wonders if some of them have slipped through) should be hired. There's no getting around the fact that some jobs are dead-end.

An applicant with limited aptitudes and interests and of a certain temperament should be considered for one of these permanent "brave" positions. Someone who does not aspire to be a "chief."

5. Poor supervision. "I remained with this company in spite of my supervisors," was the way one executive expressed it. Other less determined and tolerant individuals would not have stuck it out.

Poor supervision contributes greatly to the turnover rate. The first line supervisors can make or break a company. A new worker needs guidance—proper guidance—for several weeks. The lack of such guidance often results in terminations.

The bad publicity the ex-employe gives the company because of the poor supervision, doesn't help matters much either.

Remedy: Determine the cause of poor supervision. Are the supervisors overloaded? Are they using "old-fashioned" get-tough procedures? Are they properly trained in supervisory procedures? Are they kept adequately informed?

After determining the causes for poor supervision (which can be accomplished by inquiry and exit interviews) a training program can be set up that will provide a well-organized, properly instructed supervisory staff.

Remember, the supervisor is the "Company" to the new employe. His attitudes and policies are a direct reflection of the thinking of the com-

pany in the opinion of the worker. Therefore, to help eliminate turnover due to poor supervision, be sure the supervisor displays the correct attitude and policies.

6. Inadequate or no training program. When the new employe tries to do his job without proper training he is confused and can see little progress. If this continues, he will become disappointed and begin to think that advancement will never come.

This situation leads to low morale which in turn leads to termination. "Learning the hard way" may have been all right years ago but there is no excuse for it now. In fact, workers will not tolerate such a condition. They will seek jobs where they will be trained properly.

Remedy: Develop a well-organized training program for both new and old employes. Such programs as Induction, Orientation, Job Instruction, and Work Methods should be instigated for the new employe. Then, the following up of each of these programs with individual attention is essential. The new employe's supervisor should check constantly to see if the worker is progressing satisfactorily.

The employe should be informed of his progress. Shortcomings should be noted. Questions should be answered. By letting the new employe know where he stands and how he is progressing the supervisor is helping to cut down turnover.

A well thought out training program that "leads them by the hand" for the first few weeks can go a long way toward keeping morale high and turnover low.

7. Unsound wage structure. It is surprising how much employes know about their fellow workers' salaries. Especially since the talk of wages and salaries is supposedly taboo.

Of course there are very few salary and wage secrets. Like sex, the subject is taboo but everyone knows about it. Since this is true, any discrepancy in wages will bring about hurt feelings, low morale and general grumbling. A new employe may wonder why he is making less money than another new man that is doing the same work. If there is a legitimate reason, he should be so informed. If the reason is not legitimate—well—the supervisor will just have to get himself out of it the best way he can.

Wages that do not compete with local industry can cause turnover. That "secret" information gets around too.

Remedy: Establish a job and wage evaluation procedure. Make accurate job descriptions and compare the wages for these with comparable jobs in other like industries. Base wage scales on a fair and equitable system where prejudices and favoritism will be held to a minimum.

If the wage scale system is communicated properly to the employes, management will have nothing to hide and can answer any inquiry frankly and unafraid.

The new worker, after being informed of the wage system, will feel secure in knowing exactly what to expect on the first day and at later intervals.

A challenging situation. The causes and remedies just discussed do not exhaust the subject of turnover. However, the situation produced by a high turnover rate is a challenging one.

Careful thought and action are required if the causes are to be determined and the remedies prescribed.

Obviously if the turnover problem is going to get the attention it plainly needs, a lot of planning, reorganization, and leadership on the management level will be necessary. But once management has taken the lead in this all important problem, it will be in a position to set up red lights that will stop those policies and conditions that cause the high turnover rate.

However, we should not forget that employes too must be motivated to take a vigilant interest in the problem. Then, as both labor and management develop a sense of responsibility, and participate with each other for the common good, the low turnover rate everyone desires will be achieved.

—The End

Fluoroscopic Inspection

Continued from Page 30

fied. After experience has been obtained on the fluoroscopic unit a penetrameter sensitivity factor will be established. Present indications are that the sensitivity with a TV screen will be less than that obtained with standard radiographic techniques. With binoculars it will be possible to more closely approach the 2 percent factor for standard radiography.

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Henry

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E. B. Henry, Jr., has been with the National Tube Division Research Laboratory staff since 1948. After receiving his B.S. degree in electrical engineering from the University of Pittsburgh in 1943, Henry spent the next 3½ years in the U.S. Army Signal Corps and commanded the 338th Signal Radar Maintenance Unit. Before joining National Tube, he worked as an electronic design engineer and taught electronics in a Pittsburgh trade school.

T. A. Jones, superintendent and engineer of the Utilities Commission at Fort Valley, Ga., checks a pressure gage at the Fort Valley flow control station. Gas from Southern Natural's line flows into the run from the left.

Install Flow Controls and Use

There's a savings for gas transmission company and distribution company alike

By Joseph A. Bonner, chief engineer
Regulator Division, Rockwell Manufacturing Company
Norwalk, Ohio

BY KEEPING lateral lines pressured between the transmission line tap and the town border station, and exercising control over maximum flow, both pipe line and distribution company can effect natural gas storage that will help shave the peak demands that come in cold weather.

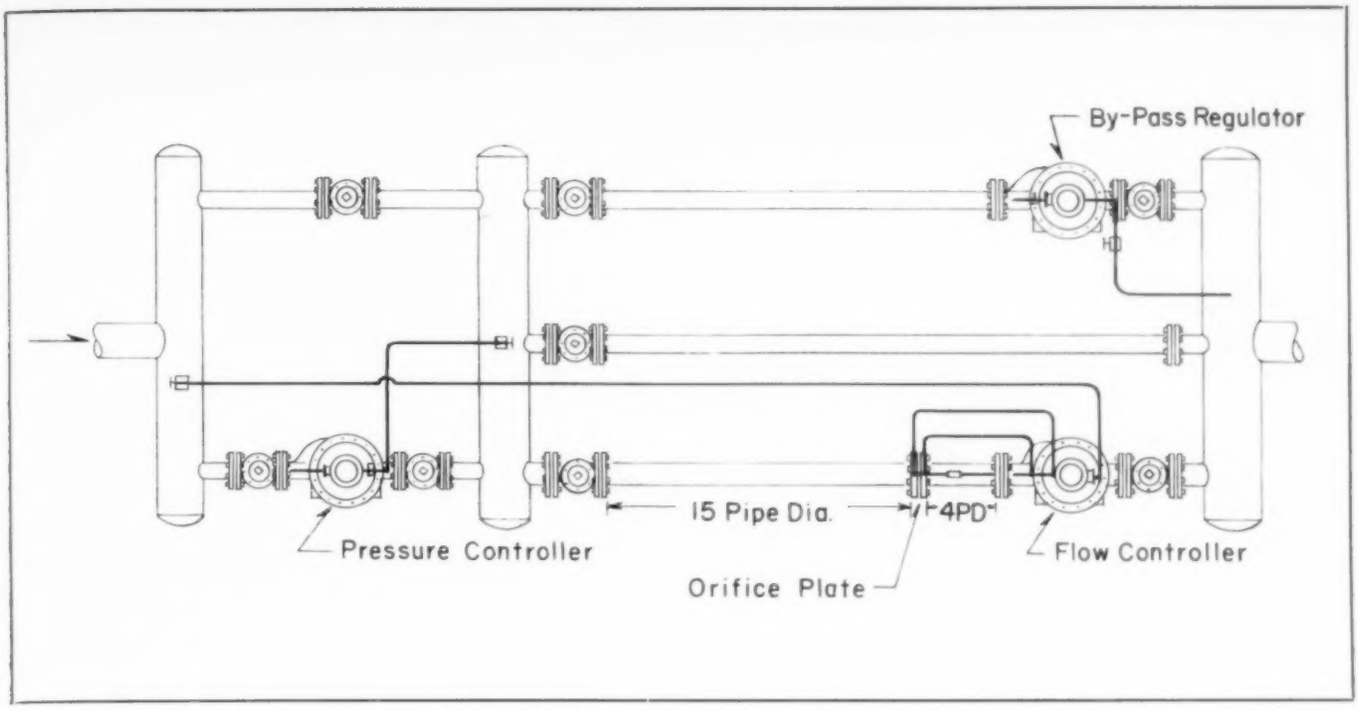
More often than not, distribution companies purchase gas on the basis of a guaranteed daily volume—excess demand to come at premium prices. This excess is undesirable for both the distributor and the pipe line company. For the latter, it may mean curtailing industrial customers to meet heating loads on cold days, and for the distribution company it means extra cost.

There's a simple remedy. Install a flow controller at the transmission line tap. This controller simply controls the upper flow limit and holds a downstream pressure differential of about seven psi maximum. A bypass will open when pressure falls to a pre-determined low point. This keeps the lateral line pressured all the way to the town border station, but, at the same time, it will not permit excess flow (above contractual purchase agreement) from the pipe line.

How Flow Station Works. As illustration of what a flow control station can do, consider company A and company B which are identical.

Both companies purchase gas from the transmission line at a guarantee of 1 million cubic feet per day. The transmission line is about 15 miles from the distribution system, and both companies have an 8-inch line between the gas source and the border stations. Company A takes gas at 500 psi and reduces it to 60 psi at the border station. Company B has the same situation, but a flow control station is located at the transmission line. The 15 miles of 8-inch line will contain about 950,000 standard cubic feet of gas at 500 pounds per square inch.

During normal cold weather, both companies supply their customers with approximately the guaranteed volume of gas, but during an exceptionally cold period, demand is boosted to 1,200,000 cubic feet per day. Company A buys the gas as it is demanded



Schematic layout of the flow control station. The idea behind this simple piping system is to prevent excess flow from the pipe line and at the same time to utilize the lateral line for gas storage which can be used to shave peak demands.

Laterals for Gas Storage

since no provision for flow control was made and therefore the additional 200,000 cubic feet per day it must purchase costs it a premium rate.

Company B is faced with the same boost in load. However, its flow control station supplies 1 million cubic feet per day to the system and the extra 200,000 cubic feet per day is taken from storage in the line between the flow control station and the town border station. Because company B set the bypass regulator for 100 pounds per square inch, the 8-inch line would contain about 212,000 standard cubic feet of gas at this pressure. Therefore, company B has 950,000 minus 212,000 or 738,000 cubic feet of gas that can be drawn from the line before it must take more than its guarantee.

Storage for 3½-Day Load. This storage would permit operation at the excess demand of 200,000 cubic feet per day for about three and one-half days, after which for illustration, the cold weather changes and the demand is reduced to 800,000 cubic feet per day. It will take three and one-half days to bring the 8-inch line back to 500 pounds per square inch pressure, but company B did not have to buy gas at premium rates and company A was forced to buy about 700,000 cubic feet at premium rates.

Control of the flow was accomplished automatically and the extra equipment could have been easily paid for in this one period of operation. This system of flow control is used by the Fort Valley Georgia Gas Company. Fort Valley buys gas from a Southern Natural Gas Transmission line and the storage required is obtained by controlling flow to the line feeding the town border station.

—**The End**

About the Author

Joseph A. Bonner, chief engineer of Rockwell Manufacturing Company's Regulator Division, is a marine engineering graduate of the State Maritime College of the University of New York. From 1950 to 1952 he served as a licensed engineer in the Merchant Marine; during 1952 to 1954 he was an engineering officer of a destroyer. Bonner joined Rockwell as a project engineer in the Gas Product Division following completion of his naval service.

A New Approach to Pressure Surge Analysis

Techniques developed by electrical engineers may be readily adapted to pipe line surge analysis

Robert D. Kersten
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PRESSURE SURGES have long been a headache of crude and products pipeliners. Despite advances in technology and equipment, surge problems for the most part remain unsolved. The net result is that the pipeliner is still concerned with:

1. The inability to predict the points of extreme fluctuating pressure in a pumping system, thereby resulting in the overdesign of the entire system.

2. Resultant unnecessary increase in size and cost of pipe line facilities.

3. Breakdowns of the pumping system from elastic failure of the pipe and pumps due to extreme fluctuating pressures.

4. Loss of revenue because "surges" necessitate the establishment of a line-limit below the normal rating of the equipment.

5. Ineffectiveness of commercial desurgers or pulsation dampeners in many situations similar in nature to those where such devices were very helpful.

A method of analysis based on a fundamental mathematical approach will be described and results of an application to a full-scale pipe line system discussed. The future applications of this method should materially aid the designer in predicting points of extreme fluctuating pressure, resulting in better over-all designs and appreciable monetary savings.

Development of a Method of Analysis. For the most part, cut-and-try empirical methods of solving water-hammer problems have been available. Many of the water-hammer and pressure-surge studies worthy of note draw heavily on the work of Allievi and Joukowski.[4, 5] The most significant contributions in this field have been summarized by the American Society of Mechanical Engineers Symposium on Water-Hammer[6] and by Wyatt.[7] Aside from being of a semi-empirical nature, the methods lean heavily on graphical methods of solution.

New Approach to an Old Problem. The fundamental equations of variable flow have been postulated by Allievi,[4] Rayleigh,[8] Lamb[9] and others. Solution of these equations, as proposed by Waller[1, 2] yields the same basic relationships found in the transmission of energy by heat, sound and electricity. It is natural, therefore, that use should be made of the techniques of analysis already well developed by the electrical engineer.

The resulting solution consists of a transient term and a steady-state term. The transient term is the water hammer solution and obviously damps out after a period of time. Analyzing the steady-state term independently, the following result is obtained for the fluctuating pressure (P) and the alternating volumetric flow rate or volume current (Q) at any point "x" distance from the receiving end:

$$P_x = P_r \operatorname{Cosh} \gamma x + Q_r Z_c \operatorname{Sinh} \gamma x \qquad (1)$$

and

What the symbols mean . . .

The symbols listed below are briefly defined, and the descriptive units refer to the gravitational (technical) system. "F" is a force usually in pounds, "L" is a length usually feet, and "T" is time usually seconds. The mass unit is the slug = 32.2 lb/g.

a — The velocity of propagation of the pressure wave. LT^{-1}, or ft. per sec.
A — Area. L^2, square ft.
A — As a subscript refers to a particular point in pipe line system; see appropriate sketches.
B — As a subscript refers to the stub or branch in the pipe line system.
d — The diameter of the piston rod. L, ft.
D — The diameter of the pipe for the pipe line analysis. L, ft.
D — The diameter of the liner for the pump analysis. L, ft.
E — As a subscript refers to equivalent parallel combination of branch and main line impedances.
f — The frequency. T^{-1}, cycles per second.
g — The gravitation constant. LT^{-2}, 32.2 ft. per $sec.^2$
i — As a subscript refers to internal mechanism of pump.
j^2 — —1, i.e., j is complex operator = $\sqrt{-1}$.
l — Length. L, ft.
m — An integer.
m — As a subscript refers to the main line.
n — The exponent of $\bar{U}$ for mean flow.
N_r — The Reynold's Number.
p — As a subscript refers to the equivalent impedance at the pump (i.e., parallel combination of sending end and internal pump impedances).
$\bar{p}$ — The mean pressure that causes a mean flow in a finite length of line. FL^{-2}, lb. per $ft.^2$
P_{sub} — The vectorial representation of the standing wave pressure amplitude. The subscript denotes the point in question. FL^{-2}, lb. per $ft.^2$
$\bar{q}$ — The mean rate of flow. L^3T^{-1}, cubic ft. per sec.
Q_{sub} — The vectorial representation of the volume current or harmonic flow rate. L^3T^{-1}, cubic ft. per sec.
Q_g — The volume current generated by the oscillating piston of the reciprocating pump. L^3T^{-1}, cubic ft. per sec.
r — As a subscript refers to the receiving end of the pipe line.
r — The radius of the crank arm or the eccentric of the crankshaft. L, ft. or ½ of stroke.
s — As a subscript refers to the sending end of the pipe line. This is usually at the pump end.
s — The stroke of the piston (2r). L, ft.
t — Time. T, sec.
U — The mean velocity of the fluid in the pipe line. LT^{-1}, ft. per sec.
v_p — The velocity of the piston in a reciprocating pump. LT^{-1}, ft. per sec.
x — The distance from the receiving end or sending end. See appropriate sketches. L, ft.
x — Used as a second subscript to denote existence of several harmonics.
Z_c — The characteristic impedance of the pipe line. $FL^{-5}T$, lb. sec. per $ft.^5$
Z_{sub} — The complex quotient of the hydromotive pressure (P) and hydraulic volume current (Q) at any point in the system denoted by the subscript. $FL^{-5}T$, lb. sec. per $ft.^5$
α — The attenuation constant. L^{-1}, numeric per ft.
β — The phase constant. L^{-1}, radians per ft. or degrees per ft.
γ — The propagation constant $\alpha + j\beta$. L^{-1}.
ρ — The density of the fluid. $FL^{-4}T^2$ per L^3 or $FL^{-4}T^2$, slugs per $ft.^3$
ϕ — The phase angle of the polar form of the vectors (degrees).
ω — The circular speed of the rotating vectors; also the angular velocity of the crankshaft. L^{-1}, radians per second.

$$Q_x = Q_r \operatorname{Cosh} \gamma x + \frac{P_r}{Z_c} \operatorname{Sinh} \gamma x \qquad (2)$$

where Z_c is a constant defined as:

$$Z_c = \frac{\rho a}{A} \qquad (3)$$

i.e. The ratio of the product of fluid density and velocity of travel of the pressure wave to the cross-sectional area of the pipe; and γ, also a constant:

$$\gamma = \alpha + j\beta \qquad (4)$$

where α is the attenuation coefficient embodying the effects of frictional resistance and β is the phase constant, i.e., the shift in the wave front as it travels down the pipe.

The reduction in magnitude of the wave as it travels down the pipe line may be determined from the attenuation coefficient:

$$\alpha = \frac{\bar{P}n}{2\,lUa\rho} \qquad (5)$$

i.e. α is the ratio of the product of mean pressure and the exponent for the mean flow (see Figure No. 2) divided by twice the product of line length, mean velocity, velocity of travel of the pressure wave and fluid density.

Beta determines the change in phase between the pressure and volume current as the pressure wave travels in the pipe line:

$$\beta = \frac{\omega}{a} \qquad (6)$$

i.e. β is the ratio of angular velocity of the pump crankshaft and the velocity of travel of the pressure wave.

Equations 1 and 2 will be recognized as being of the same form as the classical wave equations of acoustics and electrical engineering, and an electrical-hydraulic analogy becomes evident. Therefore:

$$P_x = Q_x Z_x \qquad (7)$$

i.e., ohms law for the hydraulic circuit becomes the defining equation for the impedance (Z) to the alternating flow. Equations 1 through 7 form the basis of the analysis of a pumping system. **The recognition of the electrical analogy permits the formulation of a method of hydraulic circuit analysis similar in many respects to electric circuit analysis.**

Inspection of Equation 7 reveals that, once any two of the three quantities are known at a particular point in the pipe line system, the third may be calculated. Then, by application of Equations 1 and 2, the fluctuating pressure and alternating volume current may be calculated at other points in the system. Pressure is a measurable quantity. The volume current and impedance are not.

However, the use of a reciprocating pump on a pipe line system gives rise to an alternating periodic volume current or volumetric flow rate. This periodic volumetric flow is small with respect to the mean volumetric flow rate. Since the flow is periodic, it may be analyzed by standard harmonic analysis techniques. The response of the system to the various harmonics may then be determined.

The Pump Equation. The discharge from a double-

TABLE 1—Comparison of Measured and Calculated Pressure Values

	P1 (At Pump) Measured		Qs (At Pump) Calculated		P3 (x = 32 feet) Calculated		P3 (x = 32 feet) Measured	
Harmonic	psi	∅ deg.	c. f. s.	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.22	—115.9	0.0950	—119.8	12.17	—121.4	13.05	—118.8
3	5.95	+153.5	0.0448	+142.8	5.80	+137.2	5.50	+143.6
4	13.13	— 83.4	0.0963	— 97.4	12.52	—104.7	13.55	—106.2
8	4.95	— 79.1	0.0310	—103.2	4.23	—118.6	4.50	—120.4
Prms.	13.82				13.35		14.22	

	P2 (x = 111 feet) Calculated		P2 (x = 111 feet) Measured		P5 (x = 554 feet) Calculated		P5 (x = 554 feet) Measured	
Harmonic	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.17	—129.2	13.76	—124.2	12.17	—176.4	12.17	—151.2
3	5.80	+113.7	5.84	+111.5	5.80	— 27.8	5.71	— 50.5
4	12.53	—136.1	15.32	—136.7	12.52	+ 35.3	12.40	+ 24.8
8	4.23	+178.6	4.39	+169.7	4.23	+161.4	4.00	+133.5
Prms.	13.35		15.45		13.35		13.24	

TABLE 2—Comparison of Measured and Calculated Pressure Values

	P1 (At Pump) Measured		Qs (At Pump) Calculated		P3 (x = 32 feet) Calculated		P3 (x = 32 feet) Measured	
Harmonic	psi	∅ deg.	c. f. s.	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.62	— 90.0	0.0980	— 85.8	12.77	— 96.2	12.50	—100.5
3	6.46	+145.8	0.0481	+133.5	6.23	+127.1	5.11	+122.2
4	16.46	— 90.0	0.1187	—105.4	16.72	—113.6	15.33	—118.6
8	5.18	—104.1	0.0304	—130.5	4.26	—148.2	5.17	—150.4
Prms.	15.79				15.80		14.90	

	P2 (x = 111 feet) Calculated		P2 (x = 111 feet) Measured		P5 (x = 554 feet) Calculated		P5 (x = 554 feet) Measured	
Harmonic	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.76	—105.2	11.44	—106.4	12.60	—159.7	9.89	—161.1
3	6.23	+ 99.8	4.97	+ 90.0	6.23	—115.6	4.95	— 92.6
4	16.25	—148.2	15.61	—156.8	15.57	— 8.4	12.27	— 27.6
8	4.40	+138.0	4.80	+143.8	4.25	+ 2.6	4.12	+ 33.7
Prms.	15.58		14.54		15.13		12.04	

acting duplex pump is illustrated in Figure 1 where the discharge, Q, at any position is equal to the area of the piston times the velocity of the piston, V_p, at that position.

For two double-acting cylinders, i.e., a double-acting duplex pump with one cylinder 90 degrees ahead of the other, as shown in Figure 1, and with the first cylinder referred to head end dead center a harmonic analysis gives:

$$Q = \frac{\pi r\omega}{4}\left\{\frac{4D^2 - 2d^2}{\pi} - d^2\left[\frac{r\sqrt{2}}{3\pi l}\,\mathrm{Sin}\,(\omega t + 135^\circ) + \frac{\sqrt{2}}{4}\,\mathrm{Sin}\,(\omega t + 45^\circ)\right] + \frac{rd^2}{2\pi l}\left[\sum_{m=3,7,11\ldots}\frac{4\sqrt{2}}{m^2-4}\,\mathrm{Cos}\,(m\omega t + 45^\circ) + \sum_{m=5,9,13\ldots}\frac{4\sqrt{2}}{m^2-4}\,\mathrm{Cos}\,(m\omega t + 135^\circ)\right] - \frac{(2D^2 - d^2)}{\pi}\left[\sum_{m=4,8,12\ldots}\frac{4}{m^2-1}\,\mathrm{Cos}\,(m\omega t)\right]\right\} \quad (8)$$

Similar equations may be developed for any multi-cylinder double-acting pump referenced to head-end or crank-end dead center by superimposing the effects of the required number of double-acting single cylinders properly phased.

It should be noted that the first term in Equation 8 is the mean flow ($\bar{q}$) component, while all the other terms are the variable flow components. The magnitude

TABLE 3—Comparison of Measured and Calculated Pressure Values

	P1 (At Pump) Measured		Qs (At Pump) Calculated		P3 (x = 32 feet) Calculated		P3 (x = 32 feet) Measured	
Harmonic	psi	∅ deg.	c. f. s.	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.73	— 94.7	0.0988	— 99.1	12.67	—101.4	12.39	— 98.8
3	7.17	+140.4	0.0529	+127.5	6.70	+125.2	6.55	+117.2
4	15.86	— 84.3	0.1129	—101.0	14.82	—110.2	15.17	—118.6
8	5.15	—103.4	0.0293	—139.5	4.15	—153.4	5.72	—155.7
Prms.	15.68				14.87		15.15	

	P2 (x = 111 feet) Calculated		P2 (x = 111 feet) Measured		P5 (x = 554 feet) Calculated		P5 (x = 554 feet) Measured	
Harmonic	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.68	—111.1	12.66	—108.7	12.67	—169.2	10.97	—169.9
3	6.70	+ 96.2	6.82	+ 91.3	6.70	— 78.2	5.94	—102.8
4	14.82	—148.9	13.12	—151.6	14.67	— 21.4	14.46	— 42.9
8	4.15	+129.2	5.09	+128.6	4.15	+ 24.2	3.71	— 7.4
Prms.	14.87		14.23		14.79		13.76	

TABLE 4—Comparison of Measured and Calculated Pressure Values

	P1 (At Pump) Measured		Qs (At Pump) Calculated		P1 (x = 32 feet) Calculated		P1 (x = 32 feet) Measured	
Harmonic	psi	∅ deg.	c. f. s.	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	8.70	— 90	0.0687	— 90	8.72	— 94.9	8.61	91.4
3	4.18	+117.5	0.0378	—126.6	5.28	+123.4	4.20	+ 99.6
4	8.54	—106.5	0.0920	— 95.6	9.94	—129.8	10.23	—130.6
8	1.40	— 56.3	0.0312	— 98.9	2.03	—160.9	1.79	—166.9
Prms.	9.16				10.17		9.99	

	P3 (x = 111 feet) Calculated		P3 (x = 111 feet) Measured		P5 (x = 507 feet) Calculated		P5 (x = 507 feet) Measured	
Harmonic	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	8.80	— 94.4	8.94	— 95.2	8.68	—136.4	7.89	—140.4
3	5.70	+123.4	4.62	+101.8	5.30	— 2.6	3.19	— 49.4
4	11.41	—129.8	12.17	—128.7	9.94	+ 62.2	8.86	+ 54.5
8	3.90	—160.4	3.72	—159.9	2.07	—184.8	1.86	—162.1
Prms.	11.30		11.47		10.16		8.78	

of all odd harmonics above the third and all even harmonics above the eighth is normally small in comparison to the predominant fourth harmonic. Neglecting these terms, Equation 8 may be reduced to:

$$Q = \frac{\pi r\omega}{4}\left\{\frac{4D^2 - 2d^2}{\pi} - d^2\left[\frac{r\sqrt{2}}{3\pi l}\,\mathrm{Sin}\,(\omega t + 135^\circ) + \frac{\sqrt{2}}{4}\,\mathrm{Sin}\,(\omega t + 45^\circ)\right] + \frac{rd^2}{2\pi l}\,\frac{4\sqrt{2}}{5}\,\mathrm{Cos}\,(3\omega t + 45^\circ) - \frac{(2D^2 - d^2)}{\pi}\left[\frac{4}{15}\,\mathrm{Cos}\,(4\omega t) + \frac{4}{63}\,\mathrm{Cos}\,(8\omega t)\right]\right\} \quad (9a)$$

Utilizing the following appropriate quantities applicable to a specific model pump:

D = 5½ inches = 0.458 ft.	(Liner diameter)
d = 2 inches = 0.167 ft.	(Piston rod diameter)
r = 6 inches = 0.5 ft.	(Radius of crank arm)
$\omega = (\mathrm{rpm})\frac{2\pi}{60} = 0.105\ (\mathrm{rpm})$	(Angular velocity of crankshaft)
l = 22½ inches = 2.742 ft.	(Connecting rod length)

Equation 9a then reduces to:

$$Q = 0.0103\ (\mathrm{rpm}) + 0.000816\ (\mathrm{rpm})\ \mathrm{Sin}\,(\omega t - 128.9^\circ) + 0.000221\ (\mathrm{rpm})\ \mathrm{Sin}\,(3\omega t + 135^\circ) + 0.00137\ (\mathrm{rpm})\ \mathrm{Sin}\,(4\omega t - 90^\circ) + 0.000325\ (\mathrm{rpm})\ \mathrm{Sin}\,(8\omega t - 90^\circ) \quad (9b)$$

Equation 9b is used throughout the analyses in this article as the value of the variable volume current, Q_v, generated by the pump.

TABLE 5—Comparison of Measured and Calculated Pressure Values

	P1 (At Pump) Measured		Qs (At Pump) Calculated		P2 (x = 32 feet) Calculated		P2 (x = 32 feet) Measured	
Harmonic	psi	∅ deg.	c. f. s.	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	11.92	—131.2	0.0962	—126.2	12.09	—137.6	12.48	—141.0
3	3.77	+136.2	0.0395	+146.6	4.32	+114.1	4.39	+ 74.8
4	7.21	—108.4	0.0969	—100.2	9.27	—143.7	12.83	—161.3
8	4.10	— 21.4	0.0472	—106.0	1.59	+176.8	1.14	+146.0
Prms.	10.60				11.26		13.05	

	P3 (x = 111 feet) Calculated		P3 (x = 111 feet) Measured		P5 (x = 507 feet) Calculated		P5 (x = 507 feet) Measured	
Harmonic	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	12.25	—137.6	13.72	—133.5	12.09	—191.6	12.74	—174.2
3	4.91	+114.1	5.28	+ 87.2	4.32	— 47.9	3.77	—101.6
4	11.73	—143.7	16.67	—148.6	9.27	+ 0.2	9.77	— 24.5
8	6.48	+176.3	6.28	+163.3	1.59	+104.1	5.09	+ 85.5
Prms.	13.30		16.33		11.25		11.97	

TABLE 6—Comparison of Measured and Calculated Pressure Values

	P1 (At Pump) Measured		Qs (At Pump) Calculated		P2 (x = 32 feet) Calculated		P2 (x = 32 feet) Measured	
Harmonic	psi	∅ deg.	c. f. s.	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	7.87	—114.9	0.0639	—109.4	8.01	—122.0	8.21	—125.9
3	3.88	+115.7	0.0437	+126.3	4.62	+ 90.2	5.90	+ 97.2
4	7.59	—104.3	0.1159	— 99.8	10.59	—116.4	12.14	—142.7
8	7.82	— 42.6	0.0629	—131.6	0.83	+146.4	0.23	—135.0
Prms.	9.89				9.96		11.20	

	P3 (x = 111 feet) Calculated		P3 (x = 111 feet) Measured		P5 (x = 507 feet) Calculated		P5 (x = 507 feet) Measured	
Harmonic	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.	psi	∅ deg.
1	8.15	—122.0	9.61	—131.7	8.01	—181.2	10.40	—178.1
3	5.40	+ 90.2	6.78	+ 94.8	4.61	— 89.5	4.69	— 99.9
4	14.18	—116.4	15.39	—146.2	10.59	— 25.4	9.91	— 20.4
8	7.38	+116.4	7.94	+152.9	0.83	+ 28.4	0.51	— 35.5
Prms.	13.25		14.80		9.96		10.71	

Resume of Field Tests. The test station was equipped with four, double-acting duplex, pumps. Crude oil was pumped from tankage through approximately 45 miles of 8-inch line into tankage. There were several diameter changes and short stub lines involved.

Instrumentation: Fluctuating pressures were measured and recorded with the aid of pressure cells. The output of the cells was fed into a recording oscillograph. The measured values of pressure recorded in Tables 1 through 6 were obtained from the analysis of the oscillograph traces. Recording pressure gages were used to measure the mean discharge pressures at the sending and receiving ends.

Crude oil data. Samples of crude oil were taken before, during and after the test runs. Analysis of the samples gave the following data:

Density 40.7° API at 54°F or 1.59 slugs per cubic foot. Viscosity 51.5 SUS or 13.45 x 10^{-5} lb. sec. per square foot.

Velocity of propagation: The velocity of propagation of the pressure waves in the system was determined by measuring the time required for a down surge to travel from the sending end pumps to the receiving end. The average time of travel was 59.3 seconds, giving a velocity of propagation of 4,029 feet per second.

Determination of the attenuation coefficient. The attenuation coefficient may be readily determined from

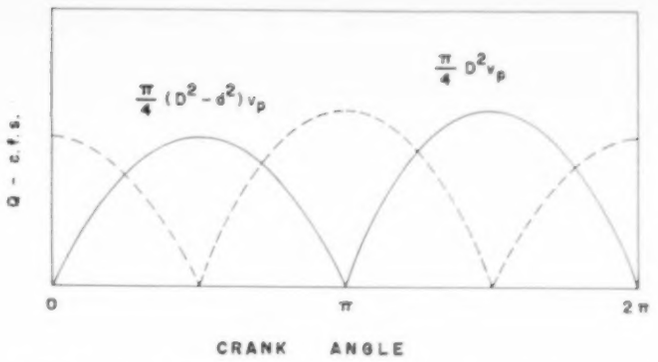

FIGURE 1—Discharge from a double acting duplex pump where the discharge, at any position is equal to the area of the piston times the velocity of the piston, V_p, at that position.

Equation 5. The mean pressure drop was plotted against the mean velocity and a value of 1.75 determined for "n" (See Figure 2). The resulting values of the attenuation coefficient were small enough to be neglected in the analysis of the test station piping.

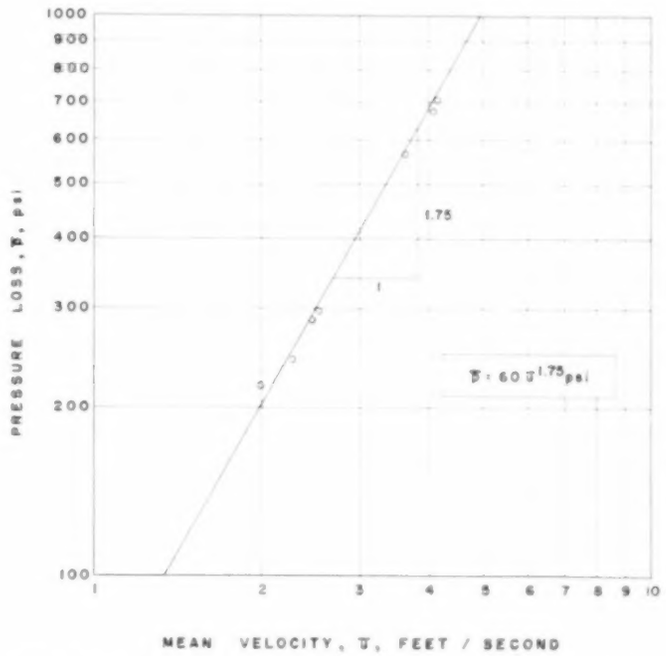

FIGURE 2—Mean velocity of the pressure wave plotted against pressure loss. To determine the reduction in magnitude of the wave as it travels down the pipe line see formula (5) in text.

Analysis. The general form of the hydraulic wave equations is given by Equations 1, 2 and 7. With αx small (i.e., Cosh $\alpha x = 1$ and Sinh $\alpha x = 0$) Equations 1, 2 and 7 reduce to:

$$P_x = P_r \cos \beta x + jQ_r Z_c \sin \beta x \qquad (10)$$

$$Q_x = Z_r \cos \beta x + j \frac{P_r}{Z_c} \sin \beta x \qquad (11)$$

$$P_r = Q_r Z_r \qquad (12)$$

as seen from the receiving end, and become:

$$P_x = P_s \cos \beta x - jQ_s Z_c \sin \beta x \qquad (13)$$

$$Q_x = Q_s \cos \beta x - j \frac{P_s}{Z_c} \sin \beta x \qquad (14)$$

$$P_s = Z_s Q_s \tag{15}$$

as seen from the sending end.

The sending end impedance may be deduced from Equations 10, 11 and 12 as:

$$Z_s = Z_c \frac{Z_r + jZ_c \operatorname{Tan} \beta l}{Z_c + jZ_r \operatorname{Tan} \beta l} = \frac{P_s}{Q_s} \tag{16}$$

and the receiving end impedance may be deduced from Equations 13, 14 and 15 as:

$$Z_r = Z_c \frac{Z_s - jZ_c \operatorname{Tan} \beta l}{Z_c - jZ_s \operatorname{Tan} \beta l} = \frac{P_r}{Q_r} \tag{17}$$

The field test pipe line system was basically composed of pumps, pipe line, and receiving end tank, as shown in Figure 3a.

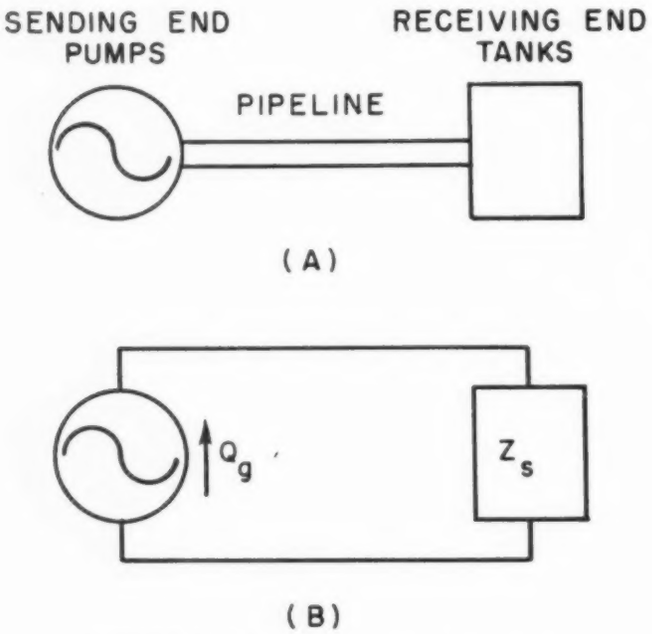

FIGURE 3—Schematic diagrams of test system.

Electrically, this system may be diagramed as shown in Figure 3b. Analysis of the system based on this arrangement gave pressure magnitudes in good agreement with measured values. However, the resulting phase angles were generally not in good agreement with measured values.

The concept of treating the pump as a constant current generator (electrically speaking) was then introduced. That is, the pump was thought of as having an internal impedance, Z_i, in parallel and generating a volume current, Q_g, which divided—part, Q_i, circulating through the internal impedance and the remainder, Q_s, flowing out into the pipe line system proper. (See Figure 4.)

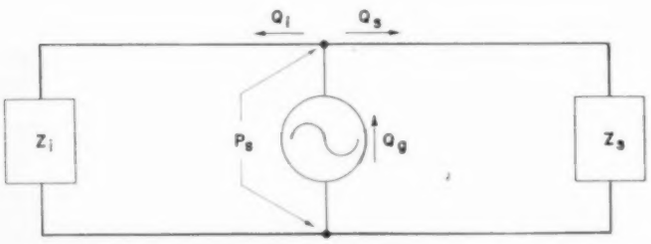

FIGURE 4—Analysis sketch treating pump as constant current generator. Pump is thought of as having internal impedance of Z_i in parallel and generating a volume current, Q_g, which divides: Q_i circulating through the internal impedance and the remainder, Q_s, flowing out into the pipe line system proper.

Then:

$$P_s = Z_s Q_s = Z_i Q_i = Z_p Q_g \tag{18}$$

and

$$Q_g = Q_i + Q_s \tag{19}$$

From Equations 18 and 19:

$$Z_p = \frac{Z_i Q_i}{Q_g} = \frac{Z_i Q_i}{Q_i + Q_s} = \frac{Z_i Z_s}{Z_i + Z_s} \tag{20}$$

or

$$Z_i = \frac{Z_p Z_s}{Z_s - Z_p} \tag{21}$$

The sending end impedance, Z_s, may be readily calculated from Equation 16. The measurement of P_s permits calculation of Q_s from Equation 18. Knowing Q_s and Q_g (from pump equation), Q_i may be easily determined from Equation 19. With the values of Q_i and Q_g known, the values of Z_i and Z_p may be established from Equation 18 or Equations 20 and 21.

If P_s and Z_s are known, the value of Q_s may be calculated. It is not necessary to determine the value of Z_i in order to proceed with the analysis.

However, if P_s is not known, it becomes necessary to evaluate Z_i by some means. This, in turn, permits evaluation of Z_p (impedance at the pump) by use of Equation 20. Then, the sending end pressure value, P_s, may be calculated from Equation 18.

In the case of the field tests, P_s was a known (measured) quantity. It was then possible to calculate Q_s and, hence, values of pressure and volume current at other points in the system.

One-pump tests with pump at the end of the line. The physical arrangement of the equipment was as shown in Figure 5. Points P2, P3, etc., denoted locations of pressure pickups.

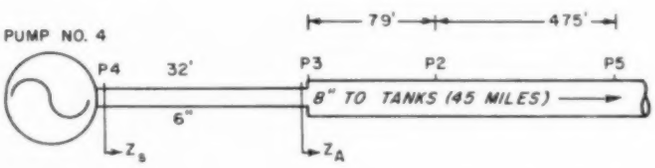

FIGURE 5—One-pump tests with pump at the end of the line. Points P_2, P_3, etc., are pressure pickups.

Applying the equations and techniques outlined in the previous section, the pressures at the various pickup points were calculated. The circuit may be visualized electrically as shown in Figure 4. Measured and calculated pressure values are compared in Tables 1, 2 and 3 (pump No. 4 at end of line operating at 66.7, 77.4 and 82.2 rpm, respectively.)

One-pump tests with pump not at the end of the line. The physical arrangement of the equipment was as shown in Figure 6.

The circuit may be visualized electrically as shown in Figure 4. However, Z_s in this case is the parallel combination of the long line and the short stub in series with

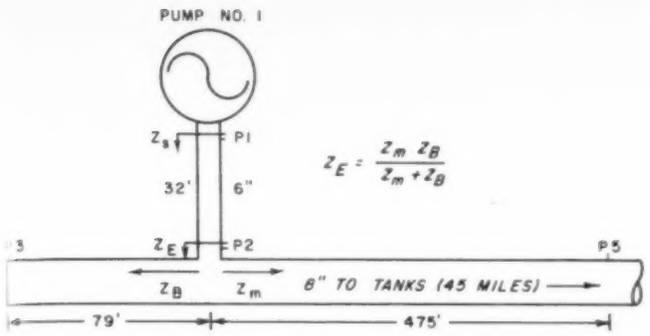

FIGURE 6—One-pump tests with pump not at the end of line. See Figure 4 for the electrical visualization of this system.

the short 6-inch line. Measured and calculated pressure values are compared in Tables 4, 5 and 6 (pump No. 1 on side branch operating at 59.4 76.4 and 84.5 rpm, respectively.)

Analysis of test results. Comparing the calculated and measured pressure values, it is noted that only one measurement differed by more than ± 4 psi and only eight by more than ± 2 psi. A statistical analysis indicated the factors that comprise the error of measurement alone might be as much as ± 4 psi. Therefore, one can only conclude that the fundamental principles and theory satisfactorily predict appropriate pressure values well within the limits of the instrumentation.

Complete information concerning the techniques of analysis, laboratory tests and field tests may be found in references 2, 10 and 11.

What The Tests Mean. The results of the work related herein adequately account for the pressure fluctuations in a reciprocating pump system. Specifically:

1. The validity of the basic underlying derivations has been established.
   (a) The fundamental principles and equations formulated in the basic theoretical analysis have been verified.
   (b) Simplification of the general mathematical expressions is valid for this case.
2. The applicability of the fundamental principles to a field-scale system has been demonstrated.
   (a) The techniques of analysis were successfully applied to an actual field installation.
   (b) It appears that the use of these results will be limited only by the ingenuity of the persons performing the analysis.
   (c) The results of this work are sufficiently general enough in nature to permit the designer to apply them to a variety of piping configurations with a high degree of confidence.

The parameters based on the concepts of the hydraulic-electric analogy have been reasonably well established. Although work should be continued on the study of these basic parameters, the main effort should be directed toward further development of techniques of analysis for more complex pipe line systems.

The basic theme of this entire research activity is the hydraulic-electric analogy. This being the case, electronic computer techniques could be applied and would greatly facilitate the preparation of much of the material in chart and graph form. Such procedures could lessen considerably the computational effort required in the analysis of many pressure-surge problems. Future work plans include application of digital computer techniques to the analysis and the use of the method of analysis in analyzing corrective devices.

ACKNOWLEDGMENTS

The work reported herein was performed by the staff of the Division of Engineering Research, College of Engineering, Oklahoma State University, Stillwater, Okla. The study was performed under the administrative direction of Dr. Clark A. Dunn, director, Division of Engineering Research. Dr. H. T. Fristoe, Professors R. L. Flanders and J. R. Norton rendered valuable assistance in related consulting capacities.

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About the Author

Robert D. Kersten, assistant professor of civil engineering, Oklahoma State University, Stillwater, Okla., holds B.S. and M.S. degrees from this institution. He was formerly a hydraulic engineer with the U. S. Department of Interior, a research engineer with Carter Oil Co. and assistant professor of engineering at Arizona State University. He is a member of ASCE and a registered professional engineer in Arizona and Oklahoma.

Flow Tests on Internally In-Place Coated Pipe

An operating company has asked us to advise readers of a correction in Figure 10, Page 42, of the July 1959 PIPE LINE INDUSTRY. Curves for the pipe line "E" factor by the Weymouth equation should read (from top to bottom) phases 3, 2, 1. As reported in the original cooperative study these were erroneously identified as phases 1, 2 and 3. Correcting the curve order in Figure 10 to read 3, 2, 1 from top to bottom will bring them into proper order for comparison with Figure 8 and 9 in that article.

IDEAS FOR THE FUTURE!

By Pipe Line Pete

... in pipe line engineering, construction and operations

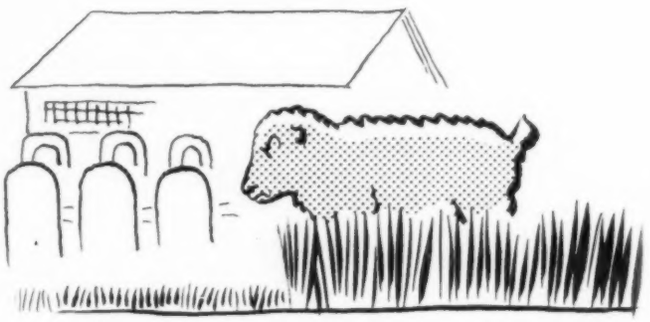
Tailored Grass May End Mowing of Station Yard

It may seem ridiculous, but one of the unsolved problems of the automatic, remotely-controlled pipe line stations is the same problem that faces most city-based pipeliners every week end in spring and summer: *How to mow the lawn with the least amount of effort!*

One company tried raising sheep with some success. The critters crop the grass conscientiously, but they are inclined to be mutton-headed where station equipment is concerned.

Another company tried centipede grass. It has a limited vertical growth but a lusty lateral expansion. The savings in mowing proved little more than the cost of trimming.

But out of our laboratories comes a new development which should prove heartening to the pipeliner. It can eliminate the lawn-mowing chore at work and still the tongue of a nagging wife on the week end. A chemical, called an anti-gibberellin, can put the brakes on grass growth, says Dr. James A. Lockhart of Cal-Tech. Used



as a spray, it will limit the growth of the stems and with grass this is about all that matters.

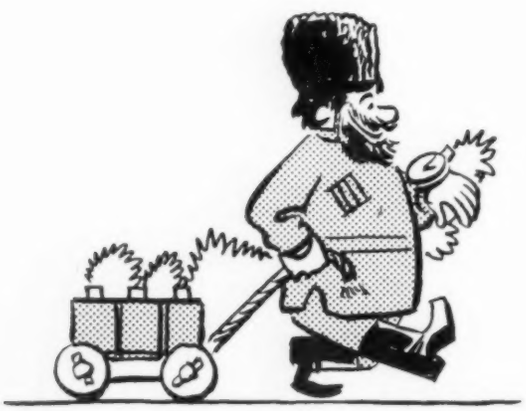
But don't sell the lawn mower yet! There's still work to be done on development of the new chemical. It may take ten years or so to perfect, according to Dr. Lockhart.

Current That Will Flow Forever—Almost

When certain uranium alloys are chilled to within one degree of absolute zero—or down to —459° F—they lose virtually all their resistance to electrical flow. In fact the resistance drops to 1/1,000,000,000,000,000 of normal!

Scientists say that if they could duplicate this effect at higher temperatures, the effect on the electronics industry would be astounding, and we would have undreamed-of gadgets. (I've never understood just how the TV works, myself, but, by George! I believe it does do better on cold nights. Hmmm. If I connected the refrigerator up . . . #*'.'.#*)

Electric Clock Accurate Within One Second in 300 Years!



Most of us won't be around to verify this, but Russian physicists say they have developed a molecular generator with such stable output that it could power an electric clock accurate within one second in 300 years. Power is supplied by radio waves emitted by molecules of ammonia, and the Russians say these molecules never deteriorate or age and their vibrations are unusually stable.

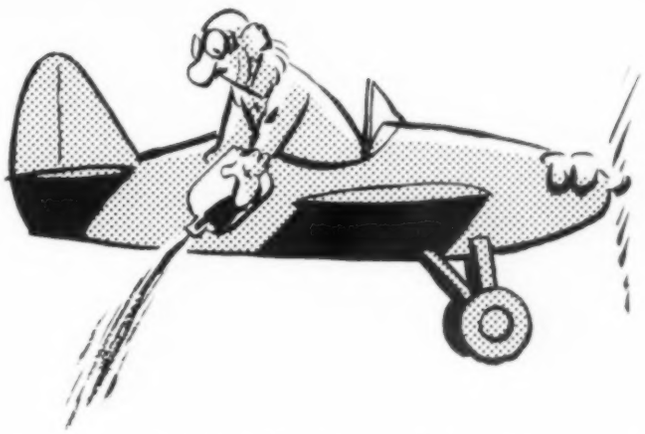
Possible uses of the new generators—precision timepieces, extra long range radar, improved radio transmission and as a basis for measuring physical and engineering values.

How Scientists Will Control the Weather

In all likelihood the time will come when weathermen will make the weather to order! Does this sound far-fetched? Think a minute, and you'll realize, we have already been exerting considerable influence on our meteorological bill of fare. By putting more and more CO_2 into the atmosphere from our engine exhaust, etc., we are lessening the severity of our winters—some scientists say. And by damming up streams and keeping more rain water in a given area we may be affecting the local rain fall. And cloud seeding is a sizeable—if not booming—business in some of the western states.

But the most drastic measure in our "weather-maker's" plans will be to change the color of snow in vast Arctic regions. It seems snow possesses the most reflective color found in nature, and if it were not for the fact that snow bounces solar heat right back out into the air and into space, snow would by no means be so long-lasting. If an inexpensive dye were broadcast by planes over snow covered areas, the ground would absorb more heat, snow would evaporate and melt faster. This in turn would perhaps cause more rain and snow; and the denuded ground would claim more solar heat, likely resulting in warmer temperatures in the Arctic regions.

This move will come as no great surprise to pipeliners. Shell Oil Company discovered that white paint could be



worth its weight in gold when applied to storage tanks filled with volatile products. Evaporation loss is but a fraction of the loss experienced with aluminum and other dark colored paints.

Another innovation along these lines: Designers have found that home owners can save on air conditioning bills with white roofs. The under-roof temperatures on hot days may run 15 to 25° F cooler than the darker colored roofs.

New Plastics to Compete With Steel, Aluminum, etc.

A year or so hence, the word *Delrin* may be as familiar to you as nylon is today. Du Pont, inventor of both of these materials, is introducing Delrin early next month when a new plant near Parkersburg, W. Va., goes on stream. Initial output will be about 1 million pounds per month.

The new plastic has been in the development stage for almost a decade. For the past three years, Du Pont has been giving away samples to encourage manufacturers to find uses for it, and once commercial production starts, Delrin will appear on the market in many forms.

Its strength approaches those of non-ferrous metals, says its developer, and it will replace metals in a number of applications. It is about 20 percent lighter than aluminum; its cost somewhat higher—about 95 cents per pound. First appearances will be in gears, bearings, instruments, camera and clock parts, carburetor parts and plumbing fixtures.

What's New in Electric Motors and Generators

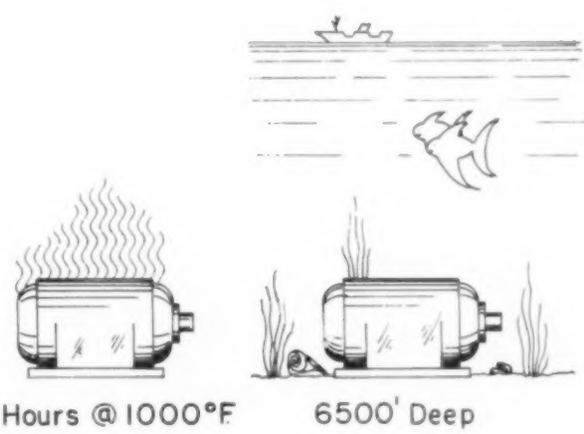
Westinghouse has developed a motor which has operated at about 1000° F for 100 hours, and General Electric has developed a motor that will operate under water.

The high temperature motor has insulating material made from fiber glass impregnated with a phosphate material. It has even operated briefly at 1200° F!

The under-water motor will operate in water at pressures up to 3,000 psi. It is built in 250- to 350-horsepower sizes.

Magnets of Aluminum?

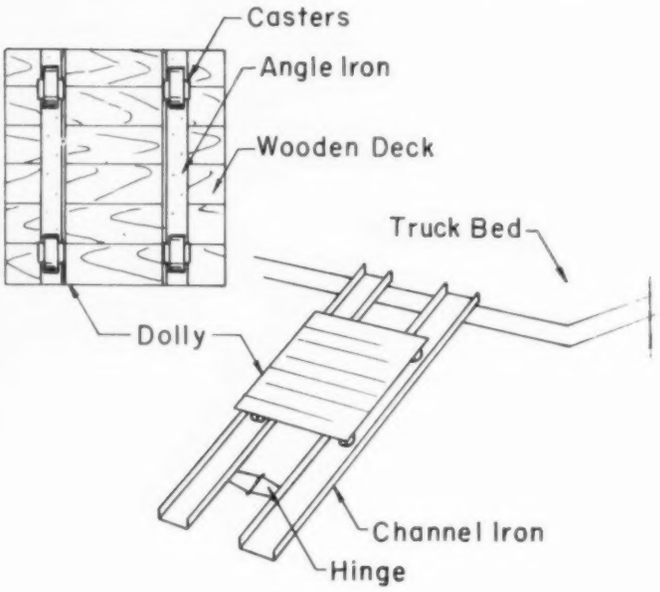
Alcoa is making an aluminum magnet wire for motors and generators which will, of course, reduce their weight and starting characteristics. The new wire will be manufactured by an Alcoa subsidiary, the Rea Magnet Wire Company of Fort Wayne and Lafayette, Ind.



How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas



Make a Portable Ramp To Ease Truck Loading

Take two pieces of 6-inch channel iron about 8-feet long each, connect them with heavy-duty hinges, and you will have a handy loading ramp that will sometimes enable one man to do the work of three. Use the two pieces of channel iron as runners for a dolly with strong casters, and you can load heavy valves and flanges onto the bed of a truck single handed.

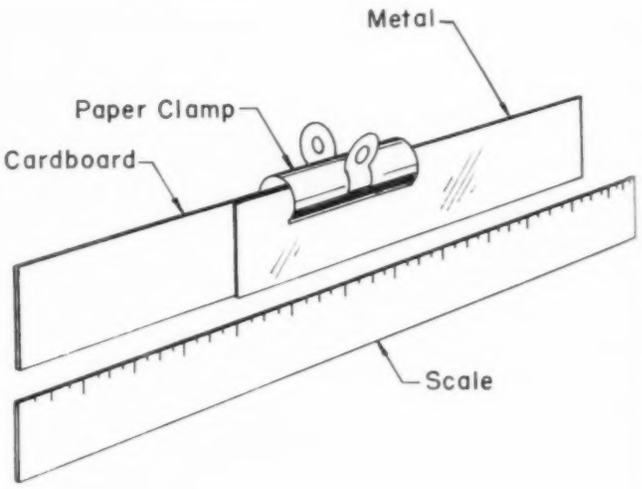
Here's the way to make it. Weld the hinges to the back or smooth side of the channel iron, then construct the dolly to fit the spacing of the two channel iron pieces. The dolly should have durable casters that will support any loads likely to be encountered.

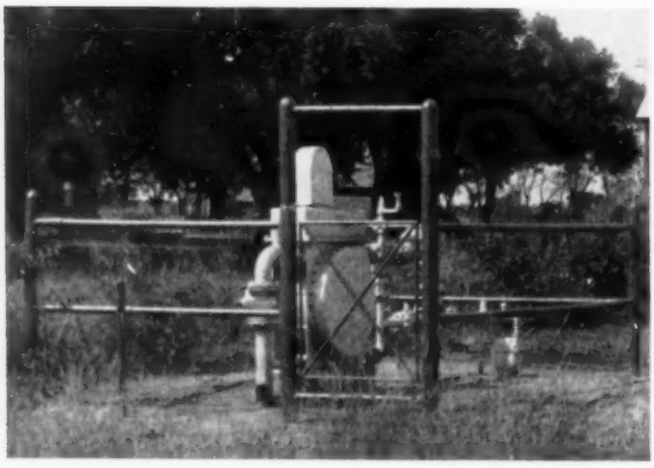
The ramp can be stored in the warehouse or shop. One man can transport it, assemble it and use it to lift moderately heavy loads onto a truck.

Home-Made Ruler Handy For Measuring Pipe ID

Sometimes it is necessary to get fairly accurate measurements of inside diameters despite the lack of proper equipment and the awkwardness of the task. Here is a solution to this problem which gives fairly accurate results.

Take a thin strip of metal and a similar strip of cardboard. Clamp them together with a paper clamp—the kind usually found in the pump station office—then insert them into the pipe or vessel. Move the two apart to obtain the maximum reading. Clamp them together, withdraw this "gage" and measure its over-all length to obtain the inside diameter.

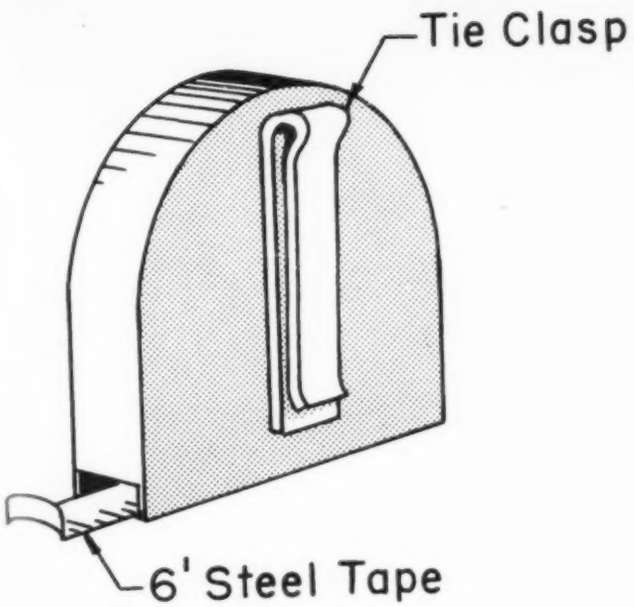




Meter Enclosure Swinging Gate Aids Chart Changer

A swinging gate hinged to one of the corner posts made extra long, and swung between another similar post 30-inches distant in the protective enclosure frame surrounding a large P/V meter for measuring gas is of considerable convenience to the chart changer and meter testing men, or anyone else wishing to inspect the meter.

A chain and padlock, not shown, keep the gate locked in closed position when not in use.



Insure Tape Measure Life With an Old Tie Clasp

Just solder an old tie clasp onto a 6-foot rule and you will find the life expectancy of the latter will skyrocket. Ordinarily the longevity of a 6-foot steel pocket tape is short because it is small, easily lost and very popular.

The tie-clasp serves two purposes. First, it holds the tape in your pocket. Second, if you do lose it, it provides an excellent means of identification.

Firing Line Machines Ride High Through Muddy Terrain

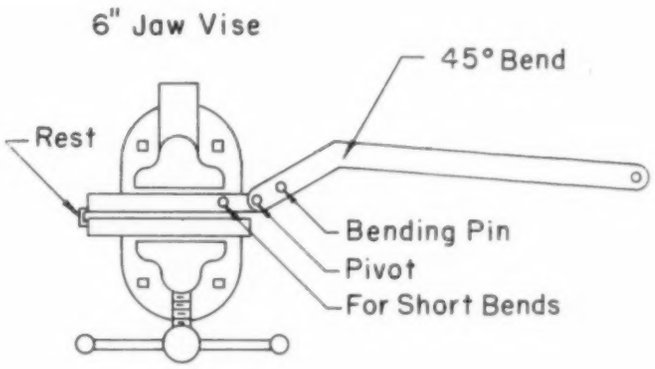
Where the right of way is muddy and crossed with innumerable streams and creeks, there's a considerable advantage in elevating the welding machine. At the same time, there are no particular disadvantages—so there's everything to gain and nothing to lose.

So—why not mount the machine 15 inches or so above the axle. Shown here is a two-wheel welding trailer. It proved successful on a swampy Florida pipe line.

Bus-Bender Fabricated From Steel Bar and Vise

There are conduit benders a-plenty, but nary a bus bender, and if you're an electrician—pipeliner type—you've faced this vexing problem every time you put in a new console, etc. But take heart, there is at least one solution to your problem, i.e. the bender shown here.

It requires a 19 by 5 by 1-inch steel bar, which is cut into two pieces 9 and 10 inches long, respectively. These are mounted in the jaws of a heavy vise, and the operating bar is attached to a longer member. To the 10-inch block, weld a foot of strap 1½ by 3/16 inches, to form a rest for the copper or aluminum bus during bending. Round off the outer end of the short block to insure smooth and crack-free 90-degree turns in the bus. For bends less than 90 degrees, drill a hole in the long block near the vise jaws to pivot the lever as the metal is bent around the tapered edge by a steady pull. The operating lever must be rugged, hence use 1 by ¾-inch bar stock. Four pieces are required; weld one 21-inch piece at approximately 155 degrees to an 8-inch piece to make one side of the lever. A corresponding side is fashioned similarly. To form a good grip, close the open end with a section of 1¼-inch bolt, over which a length of pipe of suitable dimension is slipped prior to welding. Next, weld



PLAN VIEW

the bending pin of smooth 1-inch stock between the two sides of the lever at a point 1½ inches from the pivot.

Drill a 9/16-inch hole through the lever end of the 10-inch-long bar along its edge to receive the pivot pin.

With this bender mounted in a blacksmith's vise fastened well to a suitable bench, bus bars of any reasonable dimension can be bent with comparative ease, even though the shape may vary from rectangular to square. To operate it, just open the vise, throw back the operating lever and insert the bus bar. Close the vise and pull the lever toward you.

Rules of Thumb

and Engineering Data Sheets for the Pipeliner's field notebook

$25 for Engineering Data Sheet $15 for Rule of Thumb

These practical aids give quick, reasonably accurate answers to design, maintenance and cost estimating problems. PIPE LINE INDUSTRY will pay $25 for each chart, nomograph or data sheet published—$15 for each Rule of Thumb. Send your ideas to PIPE LINE INDUSTRY, P. O. Box 2608, Houston, Texas

Miscellaneous —38—Comparing Fuel Costs for Diesel and Electric Prime Movers

Here's a formula which will give you a quick comparison of fuel costs of a pump station—for diesel engine or electric motor.

Just find out which of the expressions below, C_e or C_d is the smaller.

$$C_e = \frac{0.7457}{n} \times E$$

$$C_d = 0.065\ D + 0.04$$

where,

C_e = power consumption cost of electric motors, cents/BHP-hour.
C_d = fuel and lube oil cost of diesel engines, cents/BHP-hour.
E = electric power rate, cents/KW-hour.
D = diesel fuel cost, cents/gallon.
n = efficiency of electric motor.

Example:

Let's see which is more economical: running a 1,000 BHP unit on diesel or electric driver. The data are:

n = 95%
E = 1 ¢/KW-hr.
D = 10 ¢/gallon

So, we have:

$$C_e = \frac{0.7457}{0.95} \times 1 = 0.785$$

$$C_d = 0.065 \times 10 + 0.04 = 0.690$$

Then, for a 1,000 BHP unit the estimated operating cost per hour would be:

motor: $7.85/hour
engine: $6.90/hour

Keep in mind that this rule deals only with costs of power and fuel consumption. It does not take into consideration such expenses as operating personnel, repairs and renewals, depreciation, overhead, and so on.

Engineering Design —65—Estimate Engine Cooling Water Requirements

This formula can be used for calculating engine jacket water requirements as well as lube oil cooling water requirements:

$$GPM = \frac{H \times BHP}{500\ \Delta t}$$

where:

H = Heat dissipation in Btu's per BHP/Hr. This will vary for different engines; where they are available, the manufacturers' values should be used. Otherwise, you will be safe in substituting the following values in the formula: For engines with water-cooled exhaust manifolds: Engine jacket water = 2200 Btu's per BHP/Hr. Lube oil cooling water = 600 Btu's per BHP/Hr.

For engines with dry type manifolds (so far as cooling water is concerned) use 1500 Btu's/BHP/Hr. for the engine jackets and 650 Btu's/BHP/Hr. for lube oil cooling water requirements.

BHP = Brake Horsepower Hour
Δt = Temperature differential across engine. Usually manufacturers recommend this not exceed 15°F; 10°F is preferable.

Example: Find the jacket water requirements for a 2,000 hp gas engine which has no water jacket around the exhaust manifold.

Solution:

$$GPM = \frac{1500 \times 2000}{500 \times 10}$$

$$GPM = \frac{3{,}000{,}000}{5000} = 600 \text{ gallons per minute}$$

The lube oil cooling water requirements could be calculated in like manner.

WHAT'S HAPPENING

IN PIPE LINE CONSTRUCTION

By **Donald G. DePugh,** Construction Editor

Concrete-Coated Pipe Laid Off Brown & Root Barge L. E. Minor

Transcontinental Gas Pipe Line Corporation's offshore lateral work is nearing completion in Eugene Island Block 126 area. Pipe is moved into the first welding station, left, where joint-ends are cleaned and buffed before stringer bead is made. Pipe is shown, right, as it is shoved off barge into Gulf of Mexico after final weld and concrete field-joint coating are completed. Brown & Root is laying over 90 miles of 10 and 16-inch in offshore Louisiana area.

Transwestern Pipeline Co. Receives FPC Examiner Approval on 1,809-Mile System

Transwestern Pipeline Company has received an FPC examiner's authorization to construct its $192 million, 1,809-mile gas system from Texas-Oklahoma Panhandle area to the California border.

Contracts have been let, pending final authorization, to Houston Contracting Company, H. C. Price Company and R. H. Fulton & Company.

Transwestern's system will consist of a 670-mile, 30-inch main line from Roswell, N. M., to Topock, Ariz.; 635 miles, 24-inch feeder lines from Oklahoma Panhandle and Texas Panhandle to Roswell; and six compressor stations with a total of 49,890 horsepower. Stations will be located at a point near Amarillo, Texas, Roswell, N. M., Scholle, N. M., near Gallup, N. M., near Winslow, Ariz., and Seligman, Ariz. Transwestern's initial delivery to Pacific Lighting Gas Supply Company will be 300 MMcf of gas per day. Pacific Lighting is planning a 128-mile, 24-inch line from Topock to Los Angeles area with a 400 MMcf/d capacity.

With the future addition of eight compressor stations, Transwestern's ultimate delivery will reach 640 MMcf/d. Gas will be purchased from 14 producers and one pipe line company and will be taken from the West Texas-Permian basin and Panhandle-Hugoton fields.

Presiding examiner Harry W. Frazee said there was an urgent need for this additional gas to California, both because of the diminishing supply and of the increasingly critical air-pollution problem.

El Paso Files Application On 395-Mile Gas Pipe Line

El Paso Natural Gas Company has filed an application with the FPC seeking permission to construct a 395-mile, 34-inch gas line from Thistle, Utah, to California-Nevada border south of Las Vegas.

The line will enable El Paso to deliver a maximum of 470 MMcf of gas daily to California; Southern California and Southern Counties Gas Company will take gas from El Paso.

The $58.6 million project will connect with the proposed Colorado Interstate Gas Company 140-mile line from Rock Springs to Thistle.

Pacific Northwest Pipeline Corporation proposes to build a measuring and regulating station and sell gas to El Paso at Rock Springs.

Continental to Construct 155-Mile Products Line

Continental Pipe Line Company will construct a 155-mile products line from Artesia, N.M., to El Paso, Texas. The $2.5 million project will include building products terminals at El Paso and Albuquerque. Contract has been awarded to R. H. Fulton & Co.

The line will connect at El Paso with the Southern Pacific line to Tucson and Phoenix, Ariz., and with the Standard of Texas line to Albuquerque.

With three storage tanks, the El Paso terminal will have a capacity of 77,500 barrels and Albuquerque terminal will have a total capacity of 66,000 barrels.

Peoples Natural Gas Co. Lets Contract to Joyce

Joyce Pipeline Company will lay 46 miles of 12-and 20-inch gas lines for Peoples Natural Gas Company in Pennsylvania. The work consists of 30 miles, 20-inch pipe between Bentleyville and Imperial; 2 miles 20-inch near Yatesboro and 14 miles, 12-inch from Johnstown to Seven Springs.

Tennessee Gas Pipeline Company Lets Contracts for Station Construction

Construction has begun on Tennessee Gas Pipeline Company's $69 million compressor construction program which will increase the company's delivery capacity to more than 2.5 billion cubic feet on average days and 2.9 billion on peak days.

Addition of 113,100 horsepower with four new stations and expansion of 13 existing stations increases total hp of system 18 percent. Present hp totals 641,300 in 39 principal stations.

Tellepsen Petro-Chem is installing 8,000 hp in new stations at Bay St. Louis and Heidelberg, Miss. Western Pipe Line, Inc., is constructing 7,500 hp stations at Columbus, Miss., and Collinwood, Tenn. Additional hp is being installed at: Alexandria, 6,700 hp, by Houston Contracting Company; Winnsboro, 4,200 and Lake Providence, La., 8,100, by H. B. Zachry Company; Isola and Grenada, Miss., 7,500 and 6,700 respectively by O. L. Olsen; New Albany, Miss., 6,300 by Arthur Brothers; Savannah, Tenn., 7,500 by Houston Contracting; Centerville, Tenn., 8,100 by Western Pipe Line; Albany, Ohio, 6,800 by Arthur Brothers; Cambridge, Tenn., 7,500 by Petrocon, Inc.; Carrollton, Tenn., 8,000, Houston Contracting; Mercer and Pigeon, Pa., 2,700 and 2,000, Houston Contracting.

Northern Natural Proposes Developing Storage Facilities

Northern Natural Gas Company is seeking permission from the FPC to develop the Otis field in south central Kansas for underground storage of gas. Ultimate capacity of the facilities will be 182 billion cubic feet; in 1962 the field will be capable of delivering 245 MMcf per day and in 1963 capacity will reach 350 MMcf daily.

Other facilities included in the $20 million project are a 37-mile, 30-inch line from Bushton compressor station to the field and an additional 7,000 horsepower at the Bushton station scheduled for 1962.

Initial injection of gas on a small scale is scheduled for this fall; an existing 18-inch line from Bushton will supply gas.

Houston Pipe Line Company Lets Contract on 37 Miles

Houston Pipe Line Company has awarded a contract to Houston Contracting Company for construction of 31 miles of 12-inch, ½ mile of 18-inch and 6 miles of 24-inch gas lines in Hardin and Jefferson counties, Texas.

Pacific Petroleums Ltd. To Build Gathering System

A fourth application to build a gathering system in the same area in Canada has been received by British Columbia minister of commercial transport. Pacific Petroleums Ltd., proposes to construct a 213-mile, 3-8-inch crude gathering system from Milligan Creek and Blueberry field area to Dawson Creek.

Peace River Oil Pipe Line Co., Ltd., Gibson Petroleum Company Limited and Trans Prairie Pipelines Ltd., have filed applications for similar systems. Included in the latest plan are a 72-mile, 3-inch segment from Blueberry to Taylor, an 80-mile, 6-8-inch section from Beatton River-Milligan Creek field to Taylor; and a 34-mile, 4-inch line from Taylor to Dawson Creek.

New York State Begins Work On 37-mile Gas Line

After receiving a temporary certificate from the FPC, New York State Natural Gas Corporation let a contract to Joyce Pipeline Company to construct a 37-mile, 20-inch gas line from Luthersburg to Rural Valley, Pa.

Scheduled for completion in September, the new line will connect with two parallel existing lines near Rural Valley.

Initial operations have begun on a new underground storage pool for New York State in north central Pennsylvania. Additional 2,000 compressor horsepower will be put into operation to increase input at the Leidy pool in Clinton and Potter counties near Renovo. With 6,000 compressor hp, Trancontinental Gas Pipe Line Corporation presently is supplying gas to the pool at 120 MMcf per day. New York State, Transco and Texas Eastern Transmission Corporation are participating in the development project.

Northern Ontario Awards Compressor Station Contracts

Northern Ontario Pipe Line Crown Corporation has awarded contracts for construction of three compressor stations in Ontario, Canada.

Canadian Comstock Company Limited will install compressors at Ignace; The Fluor Corporation of Canada will build the Geraldton station; and Refinery Engineering Limited will construct the facilities at Parthia.

Service Begins Work On 44-Mile Crude Oil Line

Service Pipe Line Company has let contract to H. B. Zachry Co., to build a 44-mile, 8-inch oil line in Eddy and Lea counties, New Mexico. The line will extend from Caprock, N. M., station to Empire-Abo field. Zachry will install about 4 miles, 4-6-inch gathering lines at the field; Service plans a 100-hp electric pump station and 10,000-barrel tank to take crude from 17 leases.

Transco Awards Contracts For New Jersey Construction

Transcontinental Gas Pipe Line Corporation has awarded contracts to H. C. Price Company and J. P. Neill & Co., on 49 miles of 36-inch in New Jersey.

Price will lay 39 miles and Neill 10 miles. Transco also let contract to H & K Construction Company, Inc., on 10 miles, 8-inch and 8 miles, 10-inch near Cotulla, Texas.

Great Lakes Lets Contract On 120-Mile Products Line

The M-R Company has been awarded a contract by Great Lakes Pipe Line Company to build its 120-mile, 12-inch products line from Iowa City, Iowa, to Middleton Junction, Ill.

Great Lakes also awarded a contract to Pentzien, Inc., to install a single 12-inch submarine crossing of the Mississippi River near Princeton, Iowa.

Standard-Vacuum Oil Co. Plans 60-Mile Gas Line

Plans for a 60-mile, 8-inch, gas pipe line in Sumatra are being considered by Standard-Vacuum Oil Company. The gas line, to parallel an existing crude line, will serve a fertilizer plant near Palembang.

PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

U. S.

Alaska Juneau Gold Mining Co., Los Angeles, 425 miles, 16-inch, gas, Oklahoma City area to St. Louis, planned.

Arkansas Industrial Pipeline Corp., Shreveport, 130 miles, 18-inch, gas, Perla-to-Helena, Ark., $9 million, planned.

Atlantic Seaboard Corp., Charleston, W. Va., 26-miles, 26 and 20-inch, gas, in West Virginia, Virginia and Maryland, contract let on 19 miles to H. L. Gentry Construction Co.

Cameron Crude Oil Corp., Tulsa, 30 miles, 8-inch, crude, Harper County, Okla., fields to Clark County, Kan., planned.

Carolina Pipeline Co., gas, main line, from near Aiken to Pontiac, S. C., $5 million, approved.

Coastal States Gas Producing Co., Corpus Christi, Texas, 289 miles, 14 and 18-inch main line and gathering system, McAllen to Falfurrias, Tex., area, and Lopena to La Salle County, $12 million, contract let on 200 miles to O. R. Burden Construction Corp.

60 miles, small diameter, gas gathering line, to tie in with system under construction and extend to Pearsall County, Texas, planned.

Coastal Transmission Corp., Houston, compressor station additions and new lateral lines, $6.2 million, before FPC.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, gas, Green River, Wyo.-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colorado; 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, before FPC.

Colorado Oil & Gas Corp., Denver, 400-miles, gas, from Gubik field to Fairbanks, Alaska, planned.

Columbia Gulf Transmission Co., Houston, 12.8 miles, 6 and 20-inch, gas, loop line in Louisiana, $730,000, authorized.

41 miles, 24-inch, gas, loops, Lake Sand Junction to Arath Junction, La., before FPC. 4,000-hp, experimental compressor unit, two-cycle, turbo-charged vertical gas engine driving centrifugal compressor through a speed increaser, $1.5 million, contract let to Mid-Valley Constructors.

Commonwealth Natural Gas Co., 19 miles, 12-inch, gas, in Virginia, contract let to Latex Construction Co.

Consumers Power Co., 153-miles, 26-inch, gas, main, Michigan-Indiana border to Plymouth, Mich., contract let to Cape Construction Co. and Somerville Construction Co.

Continental Pipe Line Company, Ponca City, Okla., 155 miles, 6-inch products, Artesia, N. M., to El Paso, Texas, $2.5 million, contract let to R. H. Fulton & Co.

East Coast Pipeline Co., 90 miles, 12- to 24-inch, products, Linden, N. J. to Suffolk County, N. Y., $25 million, planned.

El Paso Natural Gas Company, El Paso, 244 miles, 30-inch, Permian-San Juan loops, 108 miles, 20-inch, field feeder lines, before FPC.

69,240 hp in new and existing stations in Texas, Oklahoma, New Mexico and Utah, planned.

400 miles, 34-inch, Salt Lake City, Utah, to California border, before FPC.

Equitable Gas Company, Pittsburgh, Penn., 11.7 miles of storage pipe line and other facilities, $2,091,430, authorized.

12½-miles, 16-inch, paralleling existing system in Harrison and Marion counties, W. Va., authorized.

Florida Pipeline & Storage Co., 54 miles, products, Port Everglades to Homestead Air Force Base, Fla., planned.

Gillette Pipeline Co., Cheyenne, Wyo., 103 miles, crude, from Dead Horse Creek field to Casper, Wyo., planned.

Great Lakes Pipe Line Company, Kansas City, Mo., 128 miles, 12-inch, products, Iowa City, Iowa and Middleton Junction, Ill., contracts let to M-R Company.

Great Northern Railway, St. Paul, 400-600 miles, 12-20 inch, crude, from Williston Basin to St. Paul-Minneapolis and Duluth-Superior areas, considered.

Gulf Resources, New York, 125 miles, gas, gathering system, from Lopena area in Zapata County to a point in La Salle County, Texas, planned.

Hope Natural Gas Co., Clarksburg, W. Va., 45 miles, gas, from West Virginia to Pittsburgh area, planned, 20 miles, 24-inch, gas, in Wertzel and Monongalia counties, W. Va., authorized.

Houston Pipe Line Company, 37 miles, 12-24-inch, gas, in Hardin and Jefferson counties, Texas, contract let to Houston Contracting Company.

Humble Oil & Refining Company, Houston, 116 miles, gas, gathering various sizes, southwest Texas, planned.

Iron Ranges Natural Gas Co., 115 miles, gas, from Itasca and St. Louis counties along route of Mesabi range from Grand Rapids to Aurora, Minn., $5 million, before FPC.

60 miles from Duluth to Silver Bay, Minn., before FPC.

Katy and New York Central Railroads, 2500-mile, 10-12 inch, LPG, from Houston, Texas, to New York, considered.

Michigan Wisconsin Pipe Line Co., Detroit, 311 miles, gas, Marshfield to Appleton, Wis., 66 miles, Illinois, Indiana, and Michigan, 5,280 hp station at Marshfield, $24 million, planned.

Midwestern Gas Transmission Co., Houston.

504 miles, 24-inch, gas, from Minnesota-Canada border near Winnipeg to Marshfield, Wis., $52 million, before FPC.

Mississippi River Transmission Corp., St. Louis, 115 miles, 24-inch, gas, Oran, Mo., to St. Louis County, planned.

Mountain Fuel Supply Co., Salt Lake City, 24 miles, 20-inch, loops in Utah; 5 miles, 8-inch lateral, Utah, before FPC.

Natural Gas Pipeline Company, Chicago, 29 miles, 10-inch lateral, in Oklahoma, before FPC.

New York State Natural Gas Co., Pittsburgh, 30 miles, 20-inch, gas, main, Silver Springs to East Elma, N. Y., $1.6 million, authorization.

37 miles, 20-inch, Luthersburgh to Rural Valley, Pa., contract let to Joyce Pipeline Company.

Northern Natural Gas Company, Omaha.

171 miles, main line extensions, 66 miles, main loops, 139 miles, branch lines, 6,000 hp additions, to extend system from Minneapolis to Duluth-Superior area, $25.7 million, before FPC.

46 miles, main line extensions, 191 miles, loops, 1,767 miles, branch lines, and 45,400 additional hp, in Iowa, Minnesota, South Dakota, Nebraska, Wisconsin and Illinois, $76.7 million, before FPC.

37 miles, 30-inch, Bushton compressor station to Otis field, Kansas, 7,000 additional hp at Bushton, and development of underground storage facilities at Otis field, $20 million, before FPC.

Ohio Fuel Gas Co., 65 miles, gas, 4-24-inch main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingum, Stark and Wayne counties, Ohio, $4.4 million, contract let on 42 miles to Shamrock Construction Co.

Okan Pipeline Company, 28 miles, 4-inch, LPG-natural gasoline, from Mocane plant in Beaver County to Liberal, Kan., station, contract let to Monarch Constructors.

Pacific Gas & Electric Co., San Francisco, 296 miles, 36-inch, gas, from Klamath Falls, Ore., to Antioch, Calif., southern section of line from Canada to California, before California Public Utilities Commission.

131 miles, 34-inch, loops, Topock-Milpitas, before FPC.

42 miles, 30-inch, gas, Pittsburg to Irvington, Calif., planned.

Pacific Gas Transmission Co., San Francisco, 614 miles, 36-inch, Kingsgate B.C. to Klamath, Ore., northern section of Canada to California line, before FPC.

Pacific Lighting Gas Supply Co., 128-mile, 34-inch, gas, main line from Topock, Ariz. to Newberry, Calif., authorized.

Pacific Northwest Pipeline Corp., Salt Lake City, 235 miles gas, gathering lines in San Juan Basin, Garmesa, Piceance Creek, and Big Piney Fields, $13.5 million, planned.

65 miles, gas, sales laterals in Washington, $1.5 million, planned.

Pennsylvania Gas Co., Warren, Penn., 38 miles, 8 and 10 inch, gas, in Erie and Warren Counties, Penn., and Chautauqua County, N. Y., $2.6 million, authorized.

Peoples Natural Gas Company, 46 miles, 12 and 20-inch, gas, in Pennsylvania, contract let to Joyce Pipeline Company.

Permian Basin Pipeline Company, Omaha, 83 miles, 16-inch, gas, from Pioneer's proposed facilities to Spraberry, Texas, and 3,960 hp compressor station, $5 million, before FPC.

Piedmont Gas Co., Hickory, N. C., 78 miles, 2-8 inch, gas, from connection with Transcontinental Gas Pipe Line to serve customers in North Carolina, $2.6 million, authorized.

Pioneer Gathering System, Inc., Amarillo, Texas, pipe line facilities in Texas costing $3.7 million, before FPC.

Pioneer Natural Gas Co., Amarillo, Texas, 62 miles, 10-inch main, Pampa, Texas, to Canyon, in Randall County, Texas, 20 miles, small diameter, gathering, 4,000 h.p. stations, $4.5 million, planned.

Phillips Petroleum Co., 25 miles, 6 to 20-inch, gas, South Eunice, New Mexico area, planned.

52 miles, 4 to 20-inch, gas, Gaines County, Texas, planned.

44-mile, 6-inch, products line, from Rocky pump stations to Amarillo, Texas, planned.

Rio Gas Gathering Co., San Antonio, 97 miles, 3 to 8-inch, gas gathering, South Texas, to supply gas to El Paso Natural Gas Company, planned.

Service Pipe Line Co., 44 miles, 8-inch, crude, Empire-Abo field to Caprock station, New Mexico, contract let H. B. Zachry Co.

Southern California and Southern Counties Gas Cos., Los Angeles, 200 miles, 34-inch, from Nevada-California border to point near Fullerton, Calif., $44 million, before Public Utilities Commission.

Southern Natural Gas Company, Birmingham, 490 miles, 16-24-inch, loop lines, gas, between Gwinville, Miss., and Wrens Ga; 62 miles, 14-inch, loops, along Atlanta-Macon line; 53 miles, 6⅝ to 14-inch, loops, along various branch lines, 3,140 additional hp at Gallion and Elmore, Ala. and Wrens, Ga. 60 miles, 20-inch, loops, in Louisiana between Franklington and White Castle and South of Toca. Lateral lines south of Gwinville and west to Cranfield field. 8,720 hp added at Franklinton, White Castle, Patterson and Brookhaven, contracts let on 355 miles to Sharman, Allen, Gay & Taylor; Oklahoma Contracting Co.; Harbert Construction Corp.; C. S. LeNoir Construction Co.; and Buchanan Contracting Co.

Tennessee Gas Pipeline Co., Houston, 21 miles, 16-inch, 2 miles, 12¾-inch, gas, Louisiana coast, Vermillion, Blocks 46 and 64, $2.9 million, before FPC.

158 miles, 36-inch, looping system in Louisiana and Mississippi, to supply Midwestern additional gas at Portland, Tenn., $61.4 million, authorized.

113,100 hp at four new stations, and 13 existing stations in Louisiana, Mississippi, Tennessee, Ohio and Pennsylvania, $69 million, contracts let to Houston Contracting Co., Western Pipe Line, Petrocon, Inc., Arthur Brothers, O. L. Olsen, H. B. Zachry Co. and Tellepsen Petro-Chem.

Texas Eastern Transmission Corp., Shreveport, La.

65 miles, gas, Delmont, Penn., to Lambertville, N. J., before FPC.

22 miles, 14-inch, gas, Rayne field to Opelousas station in Louisiana, authorized.

Texas Electric Service Company, Fort Worth, 300 miles, gas, Old Ocean field to Fort Worth, Texas, $25 million, considered.

Texas Gas Gathering Corp., Shreveport, 36.6 miles, gas, gathering system in Rodney Field, Jefferson County, Miss. and from North and South Locust Ridge, Lake St. John Field in Tensas and Concordia parishes, La., $855,413, before FPC.

Texas Gas Transmission Corporation, 246 miles, 26-30-inch, loops, between Eunice, La., and Lebanon, Ohio, 102 miles, supply lines, south Louisiana, and addition of 15,760 hp, $40 million, before FPC.

Texas Illinois Gas Pipeline Company, Chicago, 16,000 additional hp to stations at Lufkin, and Marshall, Texas; Texarkana, Malvern, Searcy, and Biggers, Ark.; Jackson, Mo.; and Hammond, Ill., $3.9 million, before FPC.

860 miles, 30-inch, loops to be constructed 1960-61.

Transcontinental Gas Pipe Line Corp., Houston, 149 miles, 36-inch, main loops, 34 miles, 20, 24-inch gathering, compressor stations at Nueces County, Texas and St. Helena Parish, La., additional hp in eight stations, $51 million, before FPC.

13 miles, 24-inch and 18 miles, 20-inch, loops, gas, four compressor stations totaling 37,280 hp, additional of 18,000 hp to eight existing stations, $29.5 million, temporary FPC authorization.

49 miles, 36-inch, New Jersey, contract let to H. C. Price Co. and J. P. Neill & Co.

Transwestern Pipeline Company, Houston, 1,305 miles, 24- and 30-inch, gas, main line, from West Texas and Oklahoma-Texas Panhandle area to Topock, Ariz., $193 million, FPC examiner approval.

Trunkline Gas Company, Houston, 204 miles, 26-inch, gas, main line from Tuscola, Ill., to Michigan-Indiana border; 464 miles, 30-inch loops between Longville, La., and Tuscola and 45 miles, 24-inch, in Texas, 183 miles gathering, Louisiana, 3000 additional hp at Longville station, $81.5 million, contracts let to Western Pipe Line, Inc., Engineers Limited Pipeline Co., C. S. Lenoir, Sam Carline, Inc., Panama, Inc., H. H. Null, Sharman, Allen, Gay & Taylor, Grayco Contractors, Contracting & Material Co., Panama-Williams and APV Company, Inc.

Underground Storage & Exploration, Upper Darby, Penn., 394 miles, 12-inch LPG, from Moundsville, W. Va. to Newark, N. J., $9 million, approved.

95 miles, 6-8 inch, laterals to Mauch Chunk, Penn., and to Philadelphia, planned.

Valley Gas Transmission, Inc., Houston, 160 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells Counties, Texas, $15 million, before FPC.

Wilcox Crude Oil Corp., Shreveport, La., 20 miles, crude line in east central Louisiana, $500,000, planned.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. government.

Alaska-Yukon Refiners and Distributors, Ltd., Edmonton, Alta., 150 miles, products, serving Alaska and Yukon territory, $3.5 million, planned.

Alberta Gas Trunk Line Company, 55 miles, 6-8-inch, laterals, in Wayne, Chancellor, Makepeace, Consort and Hilda areas, contract let to Engelking and James Ltd.

Alberta Natural Gas Company (Jointly owned by Westcoast Transmission Co. and Alberta & Southern Gas Co. Ltd.) 110 miles, 36-inch, gas, Alberta border to British Columbia-Idaho border, supply gas to Pacific Gas & Electric Co., $40 million, planned.

Arab League Oil Committee, large diameter crude line from Persian Gulf to Mediterranean Coast, $500 million, considered.

Aurine Alps Railway & Pipeline, 200 miles, crude, Venice to Munich, Germany, considered.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India, planned.

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Cia. Shell de Venezuela, 28 miles, 16-inch, western side of Lake Maracaibo, contract let to Williams Brothers Co.

Digs 55-mile trench network for water flooding in 2-mile × 4-mile field

THIS RUGGED CLEVELAND 140 dug more than 55 miles of trench through hills, brush and swamp for water flooding in a 2-mile by 4-mile Shell Oil Company field near Dale, Ill. Frost, also encountered in the course of digging the 3-foot deep trench, was no deterrent to the 140's dependable high production.

Water is pumped through the new system into selected wells under 700 pounds of pressure forcing the crude below into adjacent active wells, resulting, it is reported, in increased oil production of about 30%.

Fast, dependable Cleveland 140's have been cutting trench for field and gathering lines, and for gas, oil and product pipelines of all kinds up to 30 inches wide, for more than 20 years. Proof of their superiority lies in their widespread usage and overwhelming preference among pipeliners everywhere.

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PROPOSED CONSTRUCTION

continued

Colombian Petroleum Company, 68 miles, 12-inch, crude, Cicuco field to Covenas, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Creole Petroleum Co., 44 miles, 12-30-inch, gas, Bachaquero to Tia Juana, Venezuela, planned.

Development and Resources Corp., 70 miles, 8 inch, gas, from Agha Jari oil field to Ahwaz, Iran, planned.

Entre Nazionali Idrocarburi, Rome, Italy, crude, from Qum field in Iran to the Mediterranean Sea, considered.

Foothills Pipe Line, Ltd., 500 miles, 12 to 16-inch, LPG, from Alberta to Pacific Coast, $80 million, considered.

Gibson Crude Oil Purchasing Co. Ltd., 170 miles, crude, Milligan Creek, B. C. to Grande Prairie, Alta., planned.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 880 miles, 6-8 inch, products, from Edmonton to Winnipeg, $35 million, partial authorization.

Independent Pipe Line Co., 2,019 miles, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered.

6,150 hp pump station at Iron River, Mich., and 4,450 hp addition at Edmonton, Alta., $2 million, planned.

Iraq Petroleum Company, 80 miles, 30-32-inch, crude, loop line, Rumaila field to Fao, Iraq, planned.

Island Transmission Company Limited, Nanaimo, B.C., 25 miles, 10-inch, gas, from point near Vancouver, B.C. to Vancouver Island, 67 miles, 10-inch, laterals to Victoria and Nanaimo, B.C., $14 million, planned.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

NATO, 211 miles, crude, 6-inch, between Malatya-Cetinkaya-Erzincan, Turkey, $6 million, bids asked.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

1000 miles, 38 inch, crude, from central Iran to the Turkish Mediterranean coast, considered.

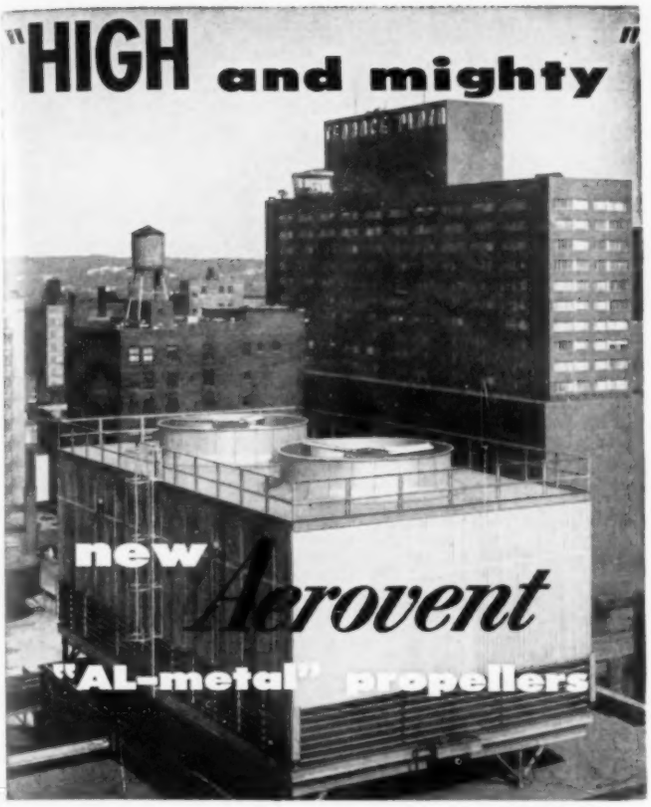
Pacific Petroleums Ltd., 213 miles, 3-8-inch, crude, gathering, Milligan Creek and Blueberry fields to Dawson Creek, planned.

Palestine Economic Corp., New York, 135 miles, 16-inch, crude, Eilat to Beersheba, Israel, to be completed July 1960.

Peace River Oil Pipe Line Co., Ltd., 70-mile, crude, Swan Hills to Iosegun Junction, approved.

230 miles, 8-inch, crude gathering, from fields in northeast British Columbia to Dawson Creek, B. C., and Grande Prairie, Alta., and to existing

"HIGH and mighty"



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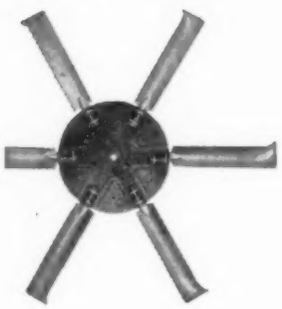
in towers and exchangers



- Sizes 14' to 18'
- 4 or 6 blades

Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

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DESIGNED FOR DEPENDABLE OPERATION!

Endurance tests, conducted at *3 times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54" to 144" now available in Adjustable Pitch Models.

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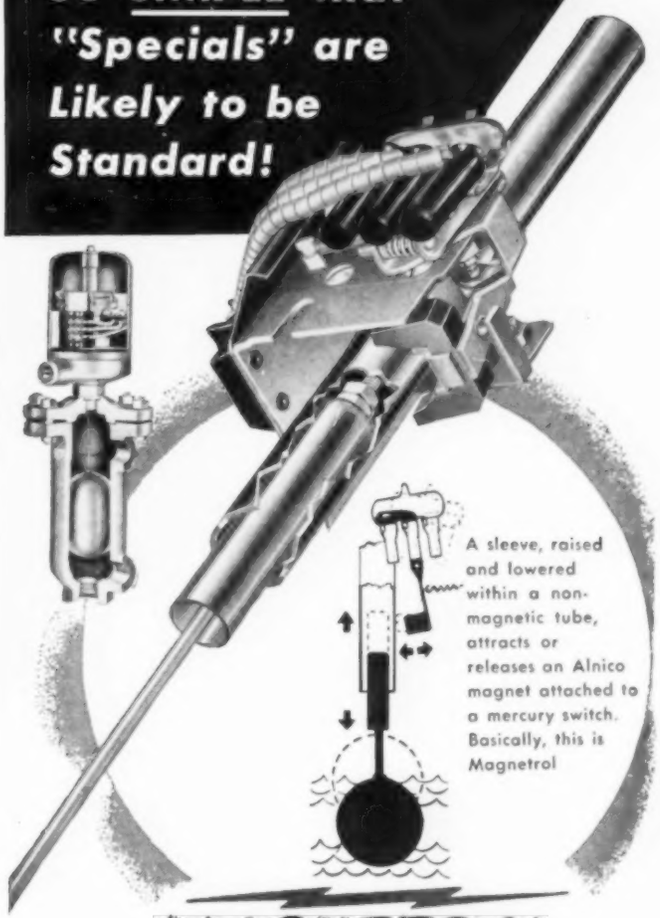
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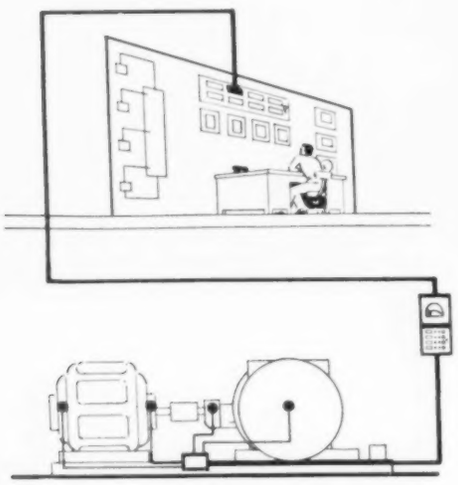
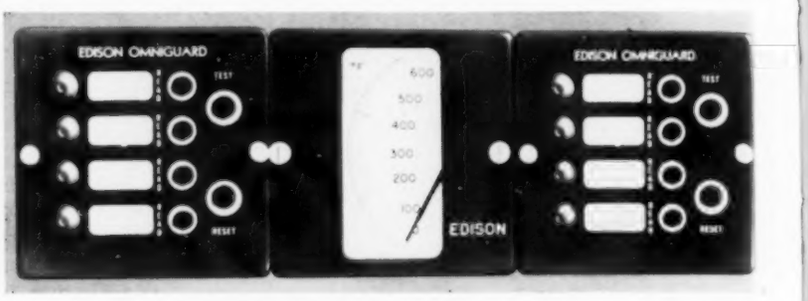
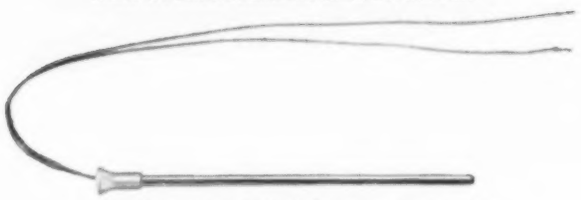


Diagram of typical OMNIGUARD System



Model 310 OMNIGUARD and Model 311 Indicator



One of Hundreds of EDISON Resistance Temperature Detectors Available.

EDISON MODEL 310 OMNIGUARD PROVES BEST FOR PUMPING STATION TEMPERATURE MONITORING

Installations at many pipe line pumping stations have proved the EDISON Model 310 OMNIGUARD Indicating and Alarm System to be the simplest, most reliable and lowest cost system yet devised to protect bearings and other critical points against excessive temperatures.

The OMNIGUARD system is simple and flexible . . . uses plug-in monitor units on a "building block" principle so that a few or many temperatures can be monitored . . . tailored to your exact needs. Units are grouped around a single indicator.

Each OMNIGUARD unit contains all of the components to monitor four temperature detectors. Its front is a 5" x 5" panel with four alarm lights and four pushbuttons used to read the four remotely located temperatures . . . **at any time.**

The system uses EDISON Resistance Temperature Detectors to measure the remotely located temperatures. EDISON RTD's are rugged, fast-acting and incredibly accurate. They can be mounted right on bearings or in pipelines. They are connected to monitor units with ordinary copper wire.

The operation of alarm or external devices can be changed quickly . . . at any time . . . by simply changing connections to the terminals on the back of the mounting case. Also, the unit allows easy tie-in with any type annunciators or cut-off switches.

Here are some of the pipe line companies using EDISON OMNIGUARD systems:

Canadian Pipeline Co.	Service Pipe Line Co.
Cherokee Pipe Line Co.	Sinclair Pipeline Co.
Continental Pipe Line Co.	Southern Pacific Pipeline Co.
Interstate Pipeline Co.	Tecumseh Pipe Line Co.

The Model 310 OMNIGUARD is available in a number of variations to meet the requirements of different applications. Model 310 OMNIGUARD Monitors can be supplied to operate on all commonly available electrical power. The power supply to be used **must be specified when ordering.**

The Model 310 OMNIGUARD Monitor is supplied as a plug-in chassis designed for either panel mounting or mounting in group enclosures or cabinets.

EXPLANATION OF NUMBERING CODE

310 — 7 A 1 A (1)

- Model Number
- Temperature/Resistance Characteristic (See Table I)
- Alarm Range (See Table II)
- Power Supply (See Table III)
- Function (See Table IV)
- Special Features—if any (Assigned with Order)

Operating characteristics can be selected from the following tables:

TABLE I

Edison T/R Characteristic	Description	Maximum Temperature
—7	120 ohm at 32°F Nickel R.T.D.	600°F
—8	100 ohm at 32°F Platinum R.T.D.	1350°F

TABLE II

	Edison T/R Characteristic	Alarm Setting Range
A		25°F— 245°F
B		145°F— 345°F
C	#7	265°F— 440°F
D		370°F— 530°F
E		455°F— 600°F
F		300°F— 810°F
G	#8	560°F—1100°F
H		760°F—1350°F

TABLE III

	Power Supply
1	115 V.A.C.—60 cps
2	115 V.A.C.—50 cps
3	115 V.A.C.—25 cps
4	24 Volt D.C.

TABLE IV

	Function
A	Operates on Rising Temperature (all channels)
B	Operates on Falling Temperature (all channels)

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SPECIFICATIONS FOR THE MODEL 310 OMNIGUARD

Power Drain: 15 watts max.
Weight: 6 lbs.
Auxiliary Contact Rating: 150 watts or 3 amp. non-inductive max.
Alarm Accuracy: ± 1% of range.
Recommended External Wiring: #16 B&S gage or larger copper wire.
Voltage Error: ± 2 F.-Max. from 100 to 130 volts (for 115. v. system).

When panel mounted the OMNIGUARD Monitor is intended for use in reasonably clean dry locations. In dusty locations or when exposed to the weather, the units should be mounted in dust-tight, weather-proof Group Enclosures which are available. Be sure to specify when ordering.

Caution:

The OMNIGUARD Monitors are not hermetically sealed and therefore are not intended for use in corrosive or hazardous atmospheres without proper purging.

Model 311 Indicator

The Model 311 Indicator designed for use with the Model 310 OMNIGUARD fits the same panel cut-out used by the Monitor. However, unlike the Monitor unit, the Indicator is supplied in its own case and no separate mounting case is required.

EXPLANATION OF PART NUMBERING CODE

311 — 7 B — 1

- Basic Model Number
- Detector T/R Characteristic
- Temperature Range
- Special Features

The following table can be used for selecting the proper Model 311 Indicator:

TABLE V

Basic Model No.	Detector T/R Characteristic	Temperature Range (Dial Scale)	Special Features
311	—7 (120 ohms at 32°F) Nickel R.T.D.	—B (—50 to 250°F) —C (—50 to 650°F) —D (0 to 300°F) —E (0 to 120°F) —F (0 to 400°F) —G (0 to 500°F) —H (0 to 600°F) —K (50 to 200°F) —L (50 to 350°F) —M (50 to 250°F) —N (100 to 400°F) —Q (100 to 200°C) —R (150 to 300°C) —S (200 to 500°F) —T (200 to 600°F) —U (300 to 600°F)	—1 No Special Features (no light) —2 Green "read" light
	—8 (100 ohms at 32°F) Platinum R.T.D.	—J (0 to 150°C) —P (100 to 600°F) —V (300 to 900°F) —W (600 to 1000°F) —X (800 to 1300°F)	—3 Amber "read" light —4 Red "read" light

Selecting the Parts for a Complete OMNIGUARD System

Each OMNIGUARD System contains one or more Monitor units, an OMNIGUARD Indicator and four Edison Resistance Temperature Detectors for each Monitor unit. In addition, a mounting case with terminal board is required to panel mount each Monitor unit, or a cabinet or group enclosure is required to house the OMNIGUARD Monitor Units and Indicator.

Hardware such as thermowells, holders, RTD heads and other fittings is also available for many of the Edison Resistance Temperature Detectors to facilitate their installation.

Details on the construction, installation and operation of the various parts comprising a complete system are given in **Catalog 3036.**

FISHER finds it faster!

All-new 1959 Transistorized

M-SCOPE PIPE FINDER

only **$189.50**

- Greatest depth penetration
- Greatest tracing distance
- Pinpoint accuracy
- One year between battery changes
- Built-in battery testers
- 90% less maintenance costs

New, Transistorized

LEAK DETECTOR

- Finds leaks faster, more accurately
- Weighs 80% LESS than ordinary equipment

only **$295.00**

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FISHER Research Lab., Inc.

Dept. PI-4, Palo Alto, Calif.

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Ask your Representative about the entirely NEW concept in Cathodic Protection! The Good-All

"AMP-O-MATIC"

Rectifier. Just set it and forget it . . . the Amp-O-Matic automatically ADJUSTS OUTPUT ITSELF!

GOOD-ALL ELECTRIC MFG. CO.

OGALLALA, NEBRASKA

PROPOSED CONSTRUCTION

continued

lines at Sturgeon Lake, $8.5 million, planned.

Pembina Pipe Line, Ltd., Edmonton, 1,200 miles, LPG, from Alberta gas fields to eastern Canada, planned.

Petroleos Mexicanos, 38 miles, 4 inch, products, from Mexico City to Toluca, $500,000 planned.

126 miles, 4, 6 and 8 inch, products, from Mexico City to Cuernavaca and Puebla, $2.5 million, planned.

214 miles, products, Monterrey to Torreon, $6.5 million, planned.

Pipelines of Puerto Rico, Inc., 95 miles, 8-inch, products, Penuelas to San Juan, Puerto Rico, planned.

Producers Pipelines Ltd., 25 miles, 4-inch, crude, Arlington Manor pool to Parkman pool, Saskatchewan, planned.

Rangeland Pipe Line Company Limited, 111 miles, 8-inch, crude, southeastern Alberta to Calgary, $3 million, planned.

Sociedad Nacional de Oleoductor, 75 miles, crude, from Santiago-to-Valparaiso, $3 million, planned.

Societa Nazionale Metanodotti, 250 miles, 18-inch, crude and products, Genoa to Milan-Cremona-Torino, Italy, and Geneva, Switzerland, considered.

Societe d'Etude du Pipe Line Sud-European, Paris, 419 miles, 30-inch, crude, port of Lavera to Strasbourg, with lateral extending 40 miles to Karlsruhe, Germany, approved by French cabinet.

Standard-Vacuum Oil Company, 60 miles, 8-inch, gas, main, in South Sumatra, considered.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

Trans-Canada Pipe Lines Limited, Toronto, compressor stations at Ignace, Geraldton and Hearst, Northern Ontario, and Maple, north of Toronto, $15.5 million, planned.

Trans-Prairie Pipelines, Ltd., Edmonton, crude line, from Weyburn field to Regina-Moose Jaw areas, $5 million, considered.

Crude line from Milligan Creek area to Dawson Creek and Fort St. John refineries, planned.

Union Gas Company of Canada Limited, 45 miles, 8-inch, gas, main, Stratford to Goderich, Ontario; 10-miles, 8-inch, main, to Amhertburg; 10-miles, 12-inch, lateral, Galt to Brantford, planned.

Westcoast Transmission Company, Ltd., 174 miles, 30-inch, gas, Savanna Creek gas field, Alberta, to British Columbian border, $45 million, planned.

Williams-McWilliams Industries, Inc., New York, 441 miles, 6-inch, crude, Villa Montes, Bolivia to Villa Hayes, Paraguay, considered.

Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina, 621 miles, 12-inch, products, Mendoza to San Lorenzo, Argentina, $19 million, planned.

281 miles, 12¾ inch, crude, Pichana to San Miguel Tucuman to Techint, S. A., planned.

450 miles, 16-inch, crude, from Neuquen Province to Bahia Blanca, planned.

Shell Starts Construction on 28 Miles in Lake Maracaibo

Williams Brothers Company has been awarded a contract to lay 28 miles of 16-inch pipe for Cia. Shell de Venezuela on the western side of Lake Maracaibo.

Williams Brothers also is laying 13 miles of 20- and 24-inch in Iowa and Illinois for Northern Natural Gas Company.

Consumers Power Company Lets Main Line Contracts

Consumers Power Company has let contracts to Cape Construction Co. and Somerville Construction Company to lay 153 miles of 24-26-inch gas main line from White Pigeon to Plymouth, Mich. The line will connect with Trunkline Gas Company's main line extension from Bourbon to Vistula, Ind.

Cape will construct the 120-mile, 26-inch main line and 22 miles of 24-inch. Somerville will lay 10 miles of 24-inch.

Rangeland Pipe Line Co. Plans 111-Mile Crude Line

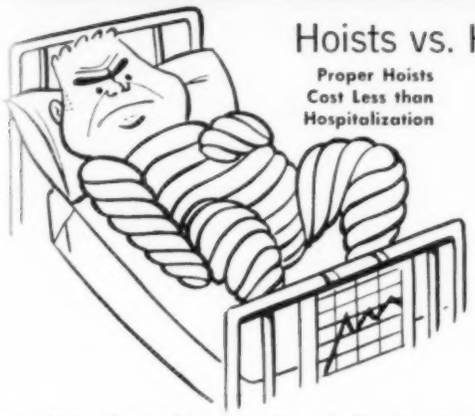
Plans for a 111-mile, 8-inch crude line to transport oil from Cessford field in Alberta to Calgary, have been formulated by Rangeland Pipe Line Company Limited. To be completed late this year, the line will have an initial capacity of 5,000 bpd and will cost $3 million.

Carolina Pipeline Company To Construct Gas System

The South Carolina Public Service Commission has approved The Carolina Pipeline Company's application to construct a gas system from near Aiken to Pontiac, South Carolina.

The Carolina gas company will take gas from Southern Natural Gas Company which will seek permission from the FPC to sell to Carolina. The $5 million construction project will begin when Southern Natural receives an okay.

Tuffy® Tips —on safe use of Slings and Hoist Lines



Proper Hoists Cost Less than Hospitalization

Hoists vs. Hernia

A manufacturer said recently that 75% of his compensation claims were connected with hernia—a common hazard in heavy lifting. About the same time, we heard from the Ohio Bureau of Workmen's Compensation that the average hernia claim (circa 1957) was $750. No need to stress the need for hoists instead of muscle for lifting tasks. Said "Occupational Hazards" magazine: (Hoists) with proper attention, given slings and periodic inspections, will help substantially in reducing back injuries and hernia claims by reducing the strain on workers."

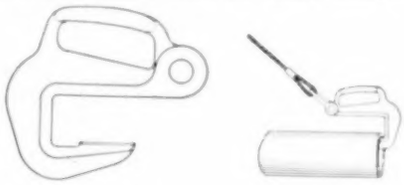
A Few Rules for Safe Use of Hoists and Slings

1. Use a proper size hoist—not human backs and muscles—for every heavy lifting job.
2. Never use load chains as slings. Chain links break easily after distortion.
3. Use the sling that's right for the job. There's a Tuffy Sling for every purpose.
4. When loading slings with more than 2 legs: load a 3-legged sling as though it had 2½ legs; load a 4-legged sling as though it had 3 legs.

Proper Fittings Give Slings Added Safety and Service Life

Union offers a sling fitting for every need. We recommend having them factory-fitted when you order your slings, but they can also be fitted in your own rigging loft. Shown here are two of a score of different fittings used on Tuffy Slings.

NEWCO STANDARD CHOKER HOOK: Standard in design, but extra high in quality and safety. Castings are always smooth and clean. No cutting or chafing slings. This hook can be attached to the end of sling instead of the main body, thus allowing the main part of the sling to be free of fittings.



NEWCO PIPE HOOK: Precisely "tailored" to the job of moving and laying pipe. High strength steel. Capacity of 3500 lbs. Pad at end allows threaded pipe to be handled without damage to threads. Eye opening is large enough to accommodate a shackle or thimble. Hook has a lifting handle for easy moving.

Made for Each Other: Tuffy Slings and Hoist Lines

Tuffy Slings and Hoist Lines make a top-performing team for every kind of hoisting work. Tuffy Slings are made of a patented, 9-part machine-braided wire fabric that's extra flexible, and isn't materially damaged by knotting or kinking. Tuffy Hoist Line is a special rope construction for use on all types of overhead cranes, derricks and clamshells—and wherever else an extra-quality, extra safe hoist line is needed. Reports from the field tell of Tuffy Hoist Lines running two and three times as long as ropes previously used.

Tuffy Kink-Resistance is Unmatched

Kinking is one of the worst hazards of wire rope and sling use. With ordinary wire rope slings, an acute kink results in serious damage and weakening that makes the rope unsafe for further use. With Tuffy, it's a different story. The super-flexible fabric is just about impossible to kink. If it does under exceptional conditions, the kink can be easily straightened out with no harm done.

Safest Ferrule Ever Made

The pressed-on steel ferrule is applied under great pressure. The ferrule metal virtually flows into voids between wires and strands of the fabric. Result: an eye splice with 100% of fabric strength, and a ferrule so smoothly tapered to the sling body that there are no abrupt edges or rough projections to snag or injure hands. And the extra service life, efficiency and safety of Tuffy's pressed-on ferrule are yours at no extra cost.

FREE! New Tuffy Sling Handbook

Revised and enlarged edition. Covers all the bases in selection and use of Tuffy Slings and fittings. Gives types, dimensions and rated loads. Includes safety-approved hand and whistle signals in operation of various equipment. Send for your copy now. **Write Union Wire Rope Corporation, 2278 Manchester Ave., Kansas City 26, Mo.**

Specialists in high-carbon wire, rope, braided wire fabric and stress relieved wire and strand.

Your Tuffy Distributor is Ready to Help You with any Sling or Wire Rope Problem

UNION Wire Rope

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NEW!

W-K-M's *Pressure Sealing* GATE VALVE

THIS BOLD ADVANCE IN VALVE DESIGN

Assures:

- ***Positive Seal***
- ***Efficient Operation***
- ***Superior Performance***

Floating Seats Give Perfect Seal. Each seat in W-K-M's *Pressure Sealing* Gate Valve consists of two kinds of rubber, formulated to W-K-M's specifications, molded to a hardened steel insert. There is a full bore opening, the same diameter as the port, through the insert.

Soft rubber, for sealing, is on the back side of each seat. Tougher, abrasive-resistant rubber is on the front or gate side. The steel insert is ringed with holes. Pressure forces the soft rubber through these holes, reinforcing the tough rubber and compensating for any wear.

Line Pressure Seals the Seats. In the closed position, the gate forms a primary seal with the raised ring of tough, firm rubber on the the face of each seat. As the line pressure is applied to the valve, the gate is forced against the rubber ring on the downstream seat and compresses it until the gate rests against the hardened steel insert. This provides a tight seal between the gate and the rubber on the face of the seat, and a secondary metal-to-metal seal. The action also forces the soft rubber on the back of the seat tightly into its recess and prevents any downstream flow at this point. The result: a bubble-tight downstream seal.

The upstream seal is caused by line pressure forcing its way into the seat recess behind the upstream seat, moving it against the gate. This pressure is sufficient to achieve a positive seal between the gate and the ring of tough rubber on the face of the seat. At the same time, the raised rim of soft rubber on the back of the seat forms a tight seal with the seat recess.

These double-action floating seats provide tight, positive seals — both upstream and downstream.

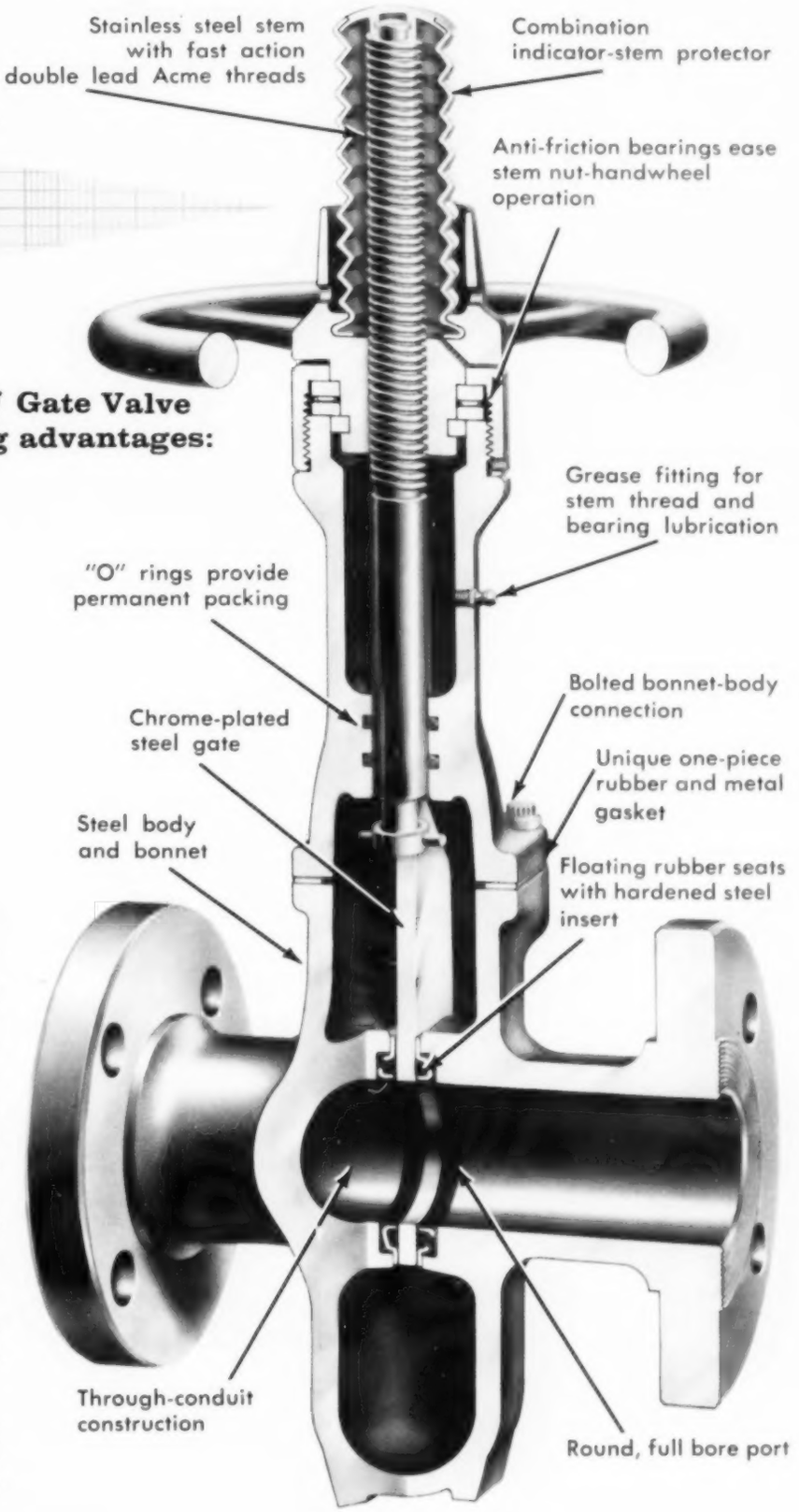
Change Seats in Minutes — On the Line! You can change the seats in W-K-M's *Pressure Sealing* Gate Valve *on the line*. The only tools needed are a wrench to loosen the body bolts, and a pair of pliers.

Important Safety Feature: This valve has been designed to automatically relieve excessive body pressure caused by thermal expansion. The excess pressure forces the upstream seat away from the gate, allowing it to bleed into the line.

Additional Advantages: The full bore, through-conduit gate construction provides a perfectly smooth bore through the valve, eliminating pockets or cavities in which foreign matter might accumulate. Result: perfectly smooth flow with no more turbulence or pressure drop than through an equal length of pipe.

W-K-M's *Pressure Sealing* Gate Valve is a two-way valve and may be installed with the pressure on either side. It is especially well suited for block and bleed service since it seals positively both upstream and downstream. The body may be bled of pressure with the gate in either the fully open or fully closed position.

ANOTHER OUTSTANDING PRODUCT OF **W-K-M's** *Creative Engineering*


Stainless steel stem with fast action double lead Acme threads
Combination indicator-stem protector
Anti-friction bearings ease stem nut-handwheel operation
Grease fitting for stem thread and bearing lubrication
"O" rings provide permanent packing
Bolted bonnet-body connection
Chrome-plated steel gate
Unique one-piece rubber and metal gasket
Steel body and bonnet
Floating rubber seats with hardened steel insert
Through-conduit construction
Round, full bore port

W-K-M's *Pressure Sealing* Gate Valve gives you all these operating advantages:

- **Tight seal both up and downstream in open and closed position**
- **Full bore, through-conduit**
- **Seats fully protected from abrasive action of lading**
- **Non-lubricated**
- **Seats automatically adjust for wear**
- **Automatic relief of excessive body pressure**
- **Ideal for abrasive ladings, light gases, volatile liquids up to 250° F.**
- **Easy to overhaul on the line**

Tested and Proved in the Toughest Services. Enthusiastic, completely favorable user reports affirm the superior quality and effortless operation of W-K-M's new *Pressure Sealing* Gate Valve. "Handles all the sludge in a gas blowout line easily – works better than any valve we've used," states a petroleum engineer. A foreman says, " . . . easiest operating valve I ever saw . . . smoothest working valve made." Similar reports covering many other services are in W-K-M's engineering test data files.

One of the Most Versatile Valves Ever Produced. W-K-M's *Pressure Sealing* Gate Valve is extremely versatile – can handle almost any low pressure job. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

ASA 150 lb. (275 cwp) and ASA 300 lb. (720 cwp)

Available Now
from your supplier. For complete information about W-K-M's new *Pressure Sealing* Gate Valve . . .
Write for Catalog 1200

3907

W-K-M 40 SERVING INDUSTRY YEARS

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NEW!

HUMBLE NEBULA EP-1 GREASE CARTRIDGES

The NEBULA EP-1 grease cartridge eliminates the worst part of greasing—the messy job of refilling the grease gun from a pail. Just slip the caps off the cartridge, insert it in your grease gun, and you're ready to grease any fitting. There's no waste of grease, and no possibility of dirt or foreign matter getting into the grease.

NEBULA EP-1 is an outstanding multi-use grease. Its exceptional resistance to the effects of heat, water, oxidation and heavy loads makes NEBULA EP-1 top choice for equipment that works outdoors where rain, moisture, dirt, dust and high temperatures are encountered.

NEBULA EP-1 gives excellent lubrication and protection whether your equipment is working at high or low speed, the load is light or heavy, and whether the temperature is hot or cold.

For quick delivery of NEBULA EP-1 grease cartridges, call your nearest Humble wholesale plant in Texas and New Mexico.

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What's Happening

among MEN in the INDUSTRY

J. W. de Groot Receives Radio

J. W. de Groot, left, who retired as president of Tuscarora Pipe Line Company Ltd., last month, is shown receiving a radio at the API Transportation conference in Pittsburgh, Pa., in May. R. K. Paine, of Standard Oil Company of California, made the presentation. De Groot retired after nearly 40 years of service with Tuscarora and parent firm Esso Standard Oil Company.

Frederick C. Schultz has retired as president and director of **Portland Pipe Line Corporation** and **Montreal Pipe Line Company Limited** after 43 years service with the affiliated companies.

Karl D. Emerson succeeds Schultz as president and director of the companies. **Franklin W. Abbott**, comptroller and assistant treasurer of Portland Pipe Line has been elected treasurer. Schultz was named manager of the Portland-Montreal pipe line system in 1941. He became president and director of Portland Pipe Line in 1946 and in 1948 was named president and director of Montreal Pipe Line Company.

Emerson joined Portland in 1951 as treasurer and assistant secretary. In 1956 he became executive assistant to the president and was made vice president and treasurer in 1958. Abbott started with the company in 1941 in the accounting department. He has been chief accountant, comptroller, and comptroller and assistant treasurer.

Clark Rankin has been elected a vice president of **Bechtel Corporation**. Rankin, who has been with Bechtel for 25 years, has been active in planning, constructing and managing many key projects, including construction of Iraq Petroleum Company pipe line from Kirkuk to the Mediterranean Sea. Presently he has general responsibility for Bechtel subsidiary companies with offices in Paris, London and The Hague.

Donovan P. Dugan has been elected president of **Tuscarora Pipe Line Company, Ltd.**, succeeding **John W. de Groot** who retired last month.

Don L. Cornell replaces Dugan as superintendent and chief engineer. De Groot retired after nearly 40 years of service with Tuscarora's parent firm, Esso Standard Oil Company. Dugan became superintendent of Tuscarora in 1947, and vice president and superintendent in 1950. In 1957 he accepted a loan assignment with the international staff of NATO in Paris and returned to Tuscarora in 1958. Cornell, chief engineer since 1954, joined Tuscarora in 1946 and was acting superintendent while Dugan was in Europe with NATO. Dugan joined the firm in 1931.

R. R. McCafferty, general pipe line superintendent, **Pioneer Natural Gas Co.**, has been elected general chairman for the 1960 Southwestern Gas Measurement Short Course to be held at the University of Oklahoma, Norman, Okla. He succeeds **R. F. Nowlin**, operations engineer, Houston distribution division, **United Gas Co.**

Buckeye Pipe Line Company has announced that **Raymond L. Hirsch** has been appointed assistant to the vice president at Lima, Ohio, and **Donald R. Merriman**, assistant to vice president at New York.

Hirsch came to the company in 1954 as an attorney. Merriman, presently vice president of **Everglades Pipe Line Company**, joined Buckeye in 1948.

Mark E. Nider has been named assistant superintendent, Communications Division, at **Natural Gas Pipeline Company** and affiliates. Nider joined NGPL in 1950 and was chief communication engineer prior to his appointment.

SAFETY

is important to the efficiency of a job, and an important part of every

SOMERVILLE

operation.

SOMERVILLE CONSTRUCTION CO.
Ada, Michigan
SIGN OF SATISFACTION
TRANSMISSION LINES
DISTRIBUTION SYSTEMS

ABILITY

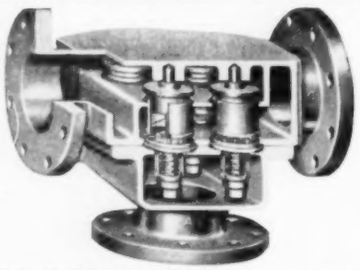
SACHSE ELECTRIC
INC.
BATON ROUGE LA.

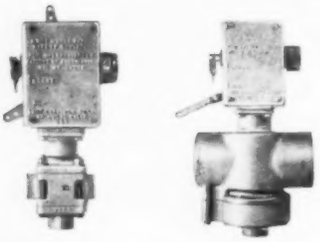
For more data on advertised products, use Readers' Service Cards, last page.

John L. Kyser has been promoted to assistant manager of the Supply and Transportation Department for **Phillips Petroleum Company.** Kyser has been with the company since 1937 and has had various assignments in engineering and materials departments before transferring in 1944 to coordinating division of Supply and Transportation Department.

Sunray Mid-Continent Oil Company announces several appointments in its supply and transportation department. **Marvin C. Jones,** formerly manager of crude traffic for **Mid-Continent Pipe Line Company,** has been named manager of foreign crude oil purchases and sales. **Don M. Shields,** former manager of crude oil purchases and sales, has been promoted to a newly created position of general manager of domestic crude oil purchases and sales. **J. W. Hawkins,** former manager of planning and development for Mid-Continent Pipe Line Co., has been named manager of economics and coordination.

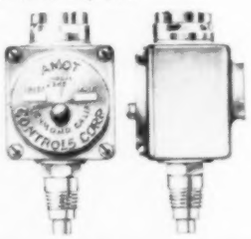
AMOT ENGINE CONTROLS





THERMOSTATIC VALVES, for jacket water and lube oil temperature control. Self contained, modulating, use no external bulbs. Sizes 1½" to 6". Temperature settings 75° F to 195° F.

MECHANICAL SAFETY CONTROL VALVES, used to shut down engines and compressors in event of oil pressure failure, overspeed, overheating of jacket water or lube oil, etc.



VENTED GAS VALVE, diaphragm operated will shut off the fuel gas and vent the manifold when used on internal combustion engine applications. Made in 2", 3" and 4" sizes.

SAFETY CONTROL SWITCH will flash warning signal, sound an alarm or close a solenoid fuel valve on overheating of jacket water or lube oil, or pressure failure of lubricating system.

AMOT CONTROLS CORPORATION

FIRST STREET & NEVIN AVENUE • RICHMOND, CALIFORNIA

THE GOODMAN CYLINDRICAL STOPPER

FOR GAS, OIL, WATER AND DRAIN PIPES

The Goodman Cylindrical Stopper is an inflatable bag with a rugged water-proofed casing which may be inflated to a high internal pressure and will hold against as much as ten pounds pressure in the pipe.

The broad central zone makes contact with the wall of the pipe and holds against a higher pressure than other types of bag.

This Stopper has been used successfully for testing soil pipes in new buildings and for stopping oil pipes around refineries. Water-works engineers use it to save pumping while altering or repairing mains where leaky valves are encountered. It is now giving satisfaction in sewer work, and in at least one instance it saved a city water-works a large expenditure of money.

Safety Gas Main Stopper Co., Inc.

523 ATLANTIC AVENUE

BROOKLYN 17, N. Y.

F. B. Sessions

C. W. Morrow

W. E. Marquis

G. E. Foulke

Columbia Gulf Transmission Company, formerly Gulf Interstate Gas Company, announces several personnel changes and reorganizational developments in its Houston office. **Floyd B. Sessions** has been named chief engineer; **Charles W. Morrow** is assistant chief engineer; **Gene E. Foulke** becomes general superintendent succeeding **Sy Orlofsky** who has been named vice president; **W. E. Marquis** replaces Foulke as gas control superintendent, and **Robert Gregory** has been promoted to director of employee relations.

Sessions joined Gulf Interstate in 1953 after serving with Trunkline Gas Company. In 1958 he was moved to Nashville, Tenn., as assistant to the general superintendent. Morrow has been with Gulf since 1954. He was named corrosion engineer in 1957 and later became pipe line engineer. He has been superintendent of District 3, Banner, since 1958. Foulke joined Trunkline in 1950 as engineer. He participated in construction of the Gulf Interstate line and then became chief dispatcher. He was promoted to gas control superintendent in 1956. Joining Gulf Interstate in 1953 on survey crew, Marquis advanced to senior dispatcher in 1957. Gregory, who has been with Gulf since 1954, had been manager of training and safety for the transmission company.

R. E. Gregory

Other appointments include **W. B. Haney,** former district superintendent of District 5, has been named assistant general superintendent and **R. S. Williams,** formerly corrosion engineer, is now pipe line engineer.

Protexa-Price, S.A. has been formed by **Humberto Lobo,** Monterrey, and **Harold C. Price,** of **H. C. Price Co.** The Mexican

Clean PIPELINES
Reclaim TANK BOTTOMS
with **BrakeSol**®
an exclusive
PARAFFIN TREATING CHEMICAL

BRAKESOL holds paraffin in suspension! Inject it into gathering lines and BRAKESOL keeps them free of paraffin.

BRAKESOL reclaims tank bottoms without taking tanks out of service! BRAKESOL chemically dissolves paraffin and puts it back in solution into the oil. Cost is nominal compared to savings.

BRAKESOL is safe to handle and will not harm your equipment. Let BRAKESOL eliminate your paraffin problems NOW!

FOR SERVICE . . . Contact your Supply Store or nearby BrakeSol Treating Engineer.

BrakeSol INC.

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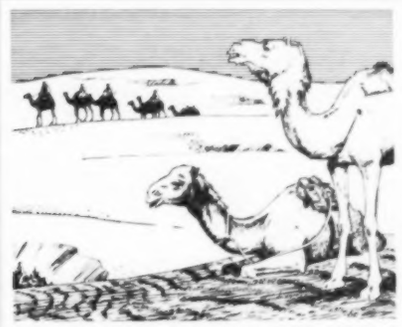
EXPORT DISTRIBUTOR: THE NATIONAL SUPPLY CO., EXPORT DIVISION

PIPELINES
are in the NEWS



Watch – **WILLIAMS BROTHERS**

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OIL • GAS • WATER • PRODUCTS
PUMPING STATIONS AND
PIPELINES

Here's An Estimating Manual
That Cannot Go Out-Of Date

ESTIMATOR'S PIPING MAN HOUR MANUAL

By John S. Page and Jim G. Nation

1959, 150 pages, illustrated — Price $7.50

Provides an accurate method of estimating direct labor for complete fabrication and installation of piping for any given system or plant. Contents cover significant factors such as: excavation, shoring and bracing, backfilling and tamping, coating and wrapping pipe, welding . . . plus many others. The manual is filled with helpful tables, charts and formulas. Also, all factors affecting productivity efficiency are included, namely: General Economy, Project Supervision, Labor Relations, Job Conditions, Equipment and Weather. The Manual should be a must for all who are concerned with estimating . . . especially contractors and engineers.

Order from:

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The New Model 412 Pressure Relief Valve

This new, improved Kinzbach Model 412 relief valve, for handling oil and heavier products at refineries and on pipelines, has a ball seated pilot valve. It is usually dead weight loaded, but can be spring loaded.

Among numerous advantages of this new valve are its dependable, positive action, with instantaneous opening and positive, automatic resealing. This is a simple, rugged valve easily tested that has high capacity and requires no pressure accumulation for full lift.

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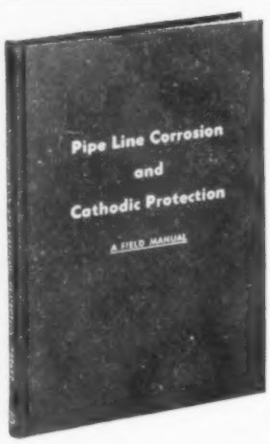

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firm has commenced work on a contrac with Petroleos Mexicanos for applicatio of hevicote concrete coating to approxi mately 43 miles of pipe. **Eddie Sikes,** H. C Price Co., and **George Morales,** Protexa are supervising the work.

Clear Span Engineering Co., Inc., an nounces the promotion of **McCall Fitz patrick** to vice president. Fitzpatrick ha been director of engineering and construc tion.

Sid Windham

D. A. Hardesty

D. A. Hardesty has been appointed superintendent of transmission and **Sid Windham** has been named general superintendent of pipe lines for **Houston Texas Gas & Oil Corporation** and **Coastal Transmission Corporation.**

Hardesty came to Houston, Texas, in 1958 with 30 years experience in the pipe line industry. He had been vice president of Natural Gas Pipeline Company of America and affiliates. Windham, who replaces Hardesty as general superintendent, was division pipe line superintendent for Coastal. Windham joined Texas Eastern Transmission Corporation in 1950. In 1956 he became assistant to the vice president of operations at **Wilcox Trend Gathering System, Inc.,** subsidiary of Texas Eastern.

New York State Natural Gas Corporation has awarded its 1959 gas technology option scholarship, worth $5,500 to **Robert G. Jump** of Elmira, N. Y. He will attend Illinois Institute of Technology at the start of the fall semester.

New York Natural will provide for tuition fees while he is attending the school and will give him summer employment during his vacation.

Interprovincial Pipe Line Company has named **D. G. Waldon** assistant general manager with headquarters in Edmonton, Alta. He replaces **F. J. Stubbs** who is moving to the company's Toronto office as assistant to the president.

Prior to joining Interprovincial in 1950, Waldon had served with Andian National Pipe Line Company for nearly 15 years. He was named treasurer of Interprovincial in 1951.

F. C. Nicholson has been elected a vice president of **Northern Natural Gas Company.** Nicholson, who joined Northern Natural in 1958, is in charge of Gas Products Development Department and a vice president of **Helex Company,** a Northern subsidiary.

WHO'S MEETING WHERE

August

Society of Automotive Engineers, national west coast meeting, Hotel Georgia, Vancouver, B. C., August 10-13.

AIEE, annual petroleum industry conference, Wilton Hotel, Long Beach, Calif., August 23-26.

West Virginia University, annual Appalachian gas measurement short course, Morgantown, W. Va., August 24-26.

Mid-West Gas Association gas school and conference, Iowa State College, Ames, Iowa, August 26-28.

September

East Panhandle Gas Course, Shamrock, Texas, September 3.

New Jersey Gas Association, annual convention, Berkeley-Carteret Hotel, Asbury Park, N. J., Sept. 4.

Pacific Coast Gas Association, annual meeting, Ambassador Hotel, Los Angeles, Sept. 9-11.

NGAA, Rocky Mountain Regional meeting, Wyoming-Gladstone Hotel, Casper, Wyo., Sept. 17.

ASME, petroleum mechanical engineering conference, Rice Hotel, Houston, September 20-23.

ISA, 14th annual instrument-automation conference and exhibit, International Amphitheatre, Chicago, Sept. 21-25.

American Welding Society, fall meeting, Sheraton-Cadillac Hotel, Detroit, Sept. 28-Oct. 1.

NACE, western region conference, Bakersfield Inn, Bakersfield, Calif., Sept. 29-Oct. 1.

October

NACE, southeast region, Robert Meyer Hotel, Jacksonville, Fla., Oct. 1-2.

NACE, northeast region, Lord Baltimore Hotel, Baltimore, Md., Oct. 5-8.

AGA, 41st annual convention, Conrad Hilton Hotel, Chicago, Oct. 5-7.

California Natural Gasoline Association, fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif., Oct. 8-9.

ACE, south central region, Cosmopolitan Hotel, Denver, Oct. 12-15.

SCE, pipe line division, annual meeting, Washington, D. C., Oct. 19-23.

ACE, north central region, Statler-Hilton Hotel, Cleveland, Oct. 20-22.

SME, ASLE, lubrication conference, Hotel Sheraton-McAlpin, New York City, October 20-22.

GAA, southern regional meeting, Carlton Hotel, Tyler, Texas, Oct. 23.

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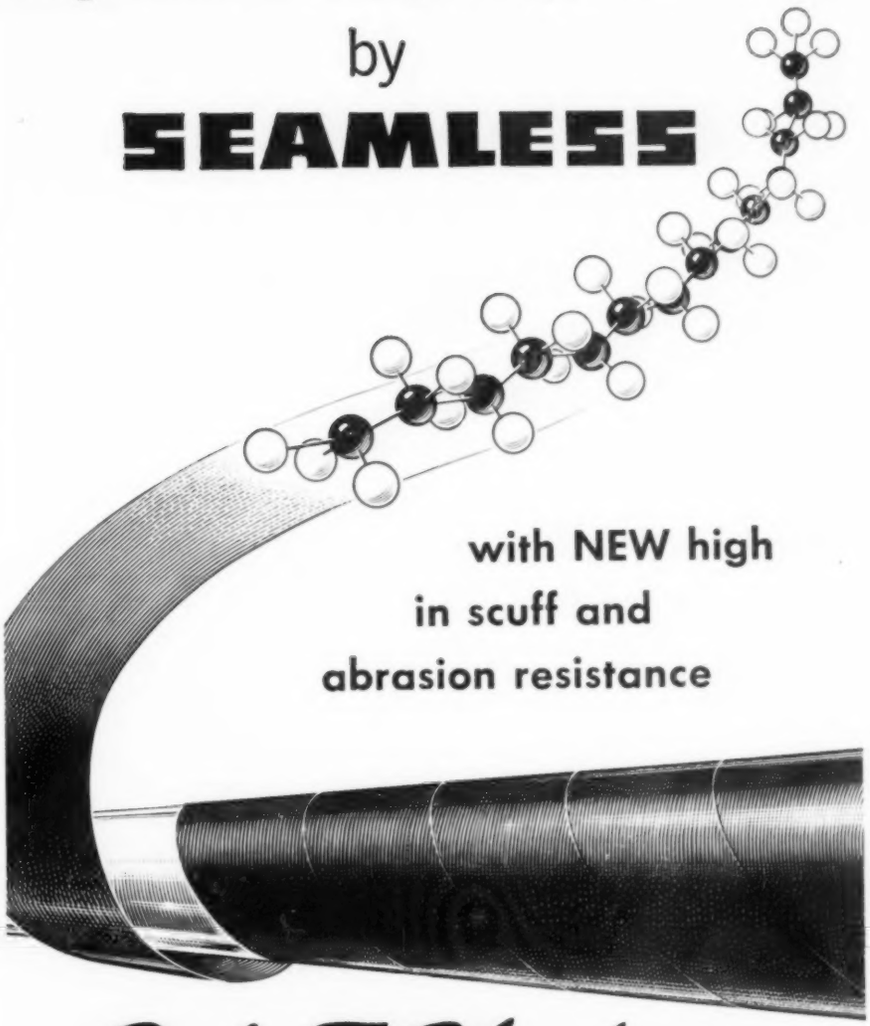

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These and similar operations at pipeline pumping stations are discussed in a new Oakite Service Report, B6878. For a free copy of this helpful report, write to Oakite Products, Inc., 51A Rector Street, New York 6, N.Y.

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ON THE LINE

"The Next 100 Years"

At a petroleum symposium titled "The Next 100 Years", to be held at the University of Houston, August 26-27, two university presidents will be among the featured speakers.

Scheduled to discuss over-all changes which seem due in the years 1959-2059 is Dr. Richard G. Folsom, president of Rensselaer Polytechnic Institute. Rev. Laurence J. McGinley, S.J., S.T.D., LL.D., president of Fordham University, will speak on the "Moral Commitment to the Coming Generations."

The two-day meeting, designed to emphasize expected problems facing the United States, the world and petroleum industry in the coming century, will also feature such speakers as Dean William T. Alexander of the College of Engineering of Northeastern University; Dr. Karl Sax, of Harvard University, expert on population problems; and Leonard J. Saccio, deputy director of the International Cooperation Administration.

Dean Alexander, immediate past president of American Society for Engineering Education, has returned recently from Russia, where he headed an educational mission to the Soviet Union. He will speak on the challenge to industry, government and education represented by coming changes.

Chairman of the executive committee for the meeting is General A. D. Bruce, chancellor of the University of Houston, 3801 Cullen Blvd., Houston.

St. Lawrence ROW, WOW!

So you think you've got right of way problems?

Construction problems surmounted in building the St. Lawrence Seaway included moving 6,500 residents and spending $30 million to relocate towns.

If that doesn't impress you, maybe this will.

Ten million bags of cement, approximately 47,000 tons of steel, and about 2 million tons of explosives were used in construction.

And just think of the size of pipe that could be laid in this ditch: Over 55 million cubic yards of earth and 18 million cubic yards of muck were excavated for the 2,363-mile seaway.

Needless to say, the paramount project was somewhat expensive. Working with money from two countries, the seaway builders spent a total of $1.21 billion for the seaway and the numerous power projects it included. The seaway construction costs totaled $47 million.

Now, who says pipe lines are expensive?

Pipe Line Technology School

Plans have been formulated for the seventh session of the semi-annual Pipe Line Technology School to be held at Baytown, Texas, September 14-October 23.

Specifically, the school is planned for supervisors and prospective supervisors in the pipe line industry, with special reference to lines carrying liquid petroleum and its derivatives. Curriculum consists of lectures, demonstrations, discussions and field trips.

Tuition, which covers instruction and class room supplies, is $300. The school is co-sponsored by the API Committee on Personnel Training, Division of Transportation and the University of Texas Petroleum Extension Service. For more information write to Petroleum Extension Service, University of Texas, P. O. Box 8024, Austin 12, Texas.

"Only the Tax Increased"

R. W. McDowell, president of DX Sunray Oil Co. told Sapulpa, Okla., civic leaders at a luncheon saluting the oil industry that a substantial portion of federal and state gasoline taxes continues to be diverted for uses other than road-building.

"Unfortunately," he said, "you don't associate this tax with national or state governments. Rather, you are inclined to regard it as just part of the ever increasing cost of gasoline. But this is wrong. Gasoline itself actually costs no more today than it did in 1952 . . . only the tax has been increased.

"Unless the American customer recognizes that increased gasoline tax is his personal business . . . gasoline taxes will continue to rise and continue to be diverted for whatever uses tomorrow's politicians may choose," said McDowell.

Pipe Line Welders Graduate

The Pipe Line Contractors Association reports that 31 men have graduated from the Tulsa pipe line industry

lders training school through June . In addition, 32 graduates have en a one to two-week refresher urse. Besides regular students, 46 lders have used the school facilities take tests successfully.

as Industry Investments

The American Gas Association has blished a public information book- "Why I invested in the Gas In- stry" which tells the story of the gas dustrys' dramatic progress under in- stor ownership.

The personalized booklet, illustrated by cartoonist Don Herold, is filled with facts and figures presented in an easy-to-read style. The booklet has been used by member companies as a mailing piece for stockholders, an employe information piece and an "open house" brochure.

Could be used for quizzes too! For instance,

What was the amount of taxes paid by gas industry in 1958?

"The gas industry . . . paid . . . $879 million in taxes, of which $350 million went to state and local governments," Page 12.

For more facts write American Gas Association, 420 Lexington Avenue, New York 17, N. Y.

Report on Russian Lubrication

According to a recent survey of published Russian literature by a U.S. government agency, "It appears that Soviet scientists are not ahead of any process, products or applications." The study included material on lubrication, lubricants and additives and formulation of lubricating compositions.

Review of abstracts of Russian technical reports appearing from 1950 through 1957 indicated that Red-nation researchers were apparently concentrating on areas fairly well known and defined by U.S. scientists. Specifically, no clear-cut references were found to work being conducted on, or use of, synthetic esters as base stocks. Also, no new or novel methods were being used to provide lubrication at extremes of temperature or extremes of equipment usage.

Greatest references related to phosphorus chemistry and a large amount of research was being expended on hydrocarbon chemistry.

For further information on this report, write to Publications & Public Information Division, Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

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130	12 to 24 in.	5¾ ft.	12 in. to 18 ft. per min.
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170	20 to 32 in.	5¾ ft.	12 in. to 25 ft. per min.
420	36 to 52 in.	7½ ft.	15 in. to 25 ft. per min.
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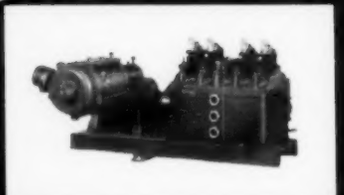

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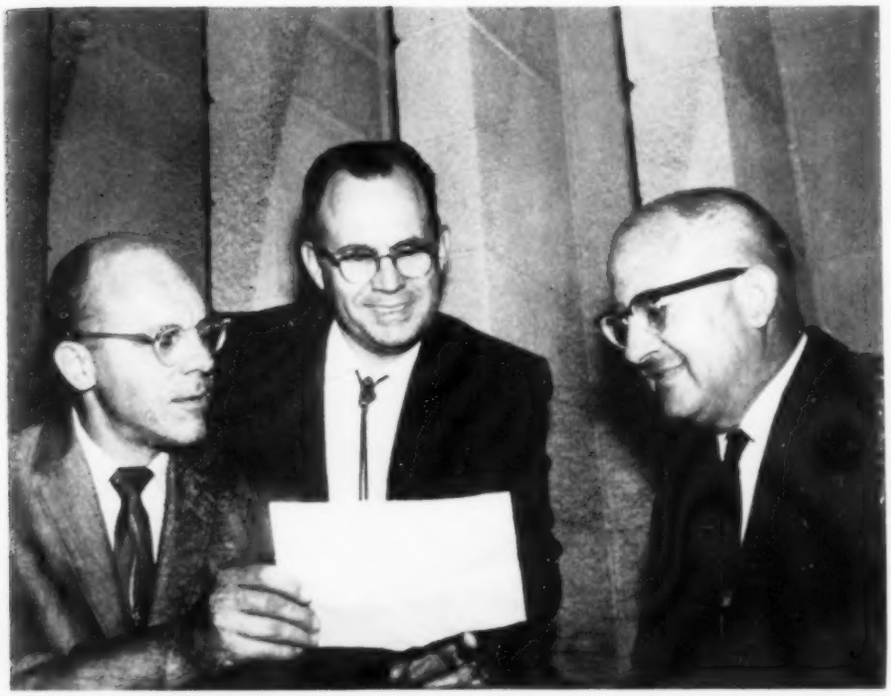

Society of Plastic Engineers

Discussing plastic pipe problems at the Society of Plastic Engineers North Texas Section meeting are Ray Perkins, left, director of technical services, Southwestern Plastic Pipe Co.; R. B. Bender, center, president of Tejas Plastics Materials and Supply Co., and Melvin Hare, president, Lone Star Plastics Co. Hare was program chairman for the meeting held June 15.

Kaiser Industries Announces Several Management Changes

The board of directors of Kaiser Industries Corporation announces several appointments in top management structure of four principal companies. Those elected to new positions are: J. L. Ashby, president and chief executive officer of Kaiser Steel Corp.; S. A. Girard, president and chief executive officer of Willys Motors, Inc.; W. A. Marsh, president and chief executive officer, Permanente Cement Company; and D. A. Rhoades, president and executive officer, Kaiser Aluminum & Chemical Corporation. Each of the above was vice president and general manager of his respective organization.

J. L. Ashby

Henry J. Kaiser, Sr., becomes founder-chairman of each organization and Edgar F. Kaiser becomes chairman of board of each organization. E. E. Trefethen, Jr., is vice chairman of the board of the four organizations.

Ashby has been with Kaiser Steel since 1942 and had been vice president and general manager since 1948.

Crane Co. Names Warren A. Logelin Director of Merged Departments

Warren A. Logelin has been named director of the consolidated public relations and advertising-sales promotion departments of Crane Co.

Formerly director of public relations, Logelin joined the company in 1955. Before coming to Crane he had been director of public relations for the Chicago Association of Commerce and Industry.

Scintilla Names Tullio Tognola Assistant Director Engineering

Tullio Tognola has been named an assistant director of engineering for the Scintilla Division of Bendix Aviation Corporation.

He has been with Bendix since 1929, and became chief research engineer in 1939. In his new position he will continue to direct research and development activities in these fields and also direct and coordinate activities of Scintilla's other engineering laboratories.

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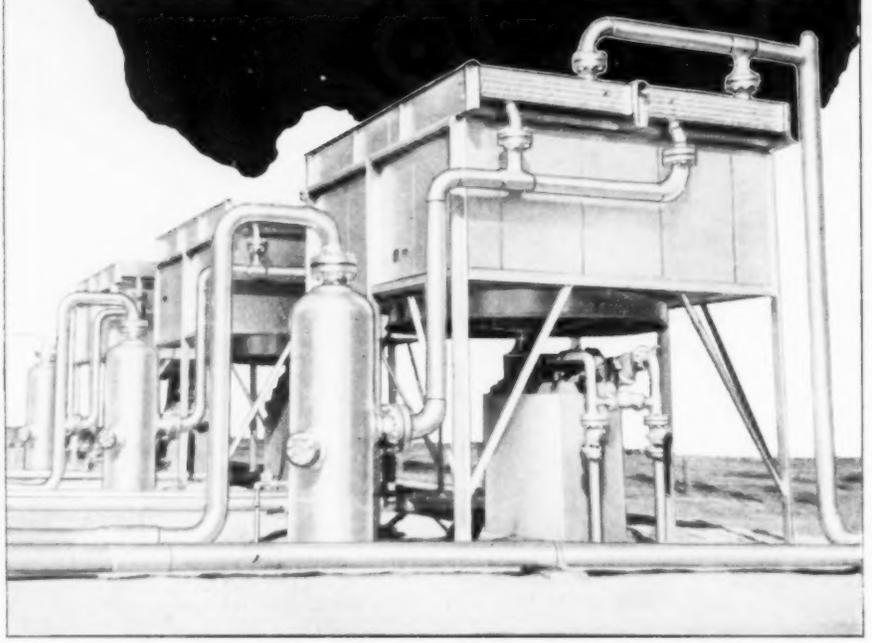

Pictured are three Young Radiator Company HC-1210 coolers handling Gas Inter-Cooling at the Tri Cities Station near Athens, Texas

The Lone Star Gas Company utilizes six HC atmospheric coolers by Young at their gas storage station near Athens, Texas. Three of these units cool Engine Jacket Water and Lube Oil on three 1350 hp Cooper-Bessemer 2-cycle Engines. The other three units do the Gas Inter-Cooling, and are designed to handle a total of 48 MMCFD to 78 MMCFD under varying conditions . . . up to 1500 psi working pressures. Young HC Units are built for rugged service. Their versatility means you get job-matched performance, according to the requirement of the heat transfer problem. Young Design and Engineering experience in the Oil Field, Petro-Chemical and Chemical Processing industries is yours for the asking. Call or write your nearest Young representative about your present or future Heat Transfer problems. No obligation of course.

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Chas. H. Creasser New Walworth Vice President—Manufacturing

Chas. H. Creasser has been appointed vice president in charge of manufacturing for the Walworth Company. Creasser comes to Walworth from Combustion Engineering Corp. He had been general manager of the corporation's East Chicago, Ind., and Chicago Raymond Division.

C. H. Creasser

Previously he served three years as a major with the Transportation Corps during the war. He will make his headquarters in Walworth's New York offices.

Black, Sivalls & Bryson, Inc. Announces Executive Promotions

Charles H. Myers, vice president and manager of Oilfield Equipment Division has been promoted to industrial relations vice president. Floyd C. Myers, vice president and manager of Oilfield Sales and Service, has been appointed Houston vice president and Paul Bartley, vice president of Black, Sivalls, & Bryson, Ltd., has been appointed manager of Oilfield Equipment Division, Oklahoma City.

C. H. Myers has been a vice president and member of the board of directors since 1946. F. C. Myers, with 29 years service, has been manager of Oilfield Sales and Service since 1954. Bartley, who has been with BS&B for 20 years, was named vice president and general manager in charge of Canadian operations in 1953.

Fischer & Porter Names Hughes Projects Engineer

Fischer & Porter Co. has named A. R. Hughes to the newly created position of special projects engineer. Hughes formerly had been manager of Philadelphia district office of Brooks Rotameter Company.

Hughes will aid in development of the new markets for the company.

Collins Radio Company Announces Three Division Executive Appointments

Collins Radio Company announces three executive appointments in its recently organized Cedar Rapids Division. J. C. McElroy has been named director of development; Dr. R. L. McCreary, director of research and W. W. Roodhouse, director of sales. A. S. Born will serve as assistant to R. T. Cox, vice president of the division.

E. A. Williams will continue to serve as controller for the division, G. G. Johnson will continue to head industrial relations and J. H. Wagner will remain as head of purchasing.

John F. Partridge Promoted By American Steel Foundries

John F. Partridge, formerly assistant secretary of American Steel Foundries, has been promoted to secretary and counsel, succeeding Orrin B. Garner, who retired.

Walter L. Schlegel, Jr., patent attorney, was appointed assistant secretary and chief patent attorney and Melvin C. Holmes, attorney, was named assistant secretary.

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Because Southwestern LIGHTWALL greatly reduces weight without sacrificing performance . . . it is today's biggest value for your pipeline dollar. Southwestern LIGHTWALL Electric Resistance-Weld Line Pipe offers the same or greater tensile strengths and working pressures of standard weight pipe of the same I.D. That's why you save four ways with LIGHTWALL.

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Crane Co. Elects Songer Executive Vice President

Wesley A. Songer has been elected executive vice president of the Crane Company. Songer had been executive vice president for the American Safety Razor Corp., and previously had been on the president staff at General Electric.

W. A. Songer

Songer had joined American Safety Razor Corp. as vice president and general manager in 1952 and a year later was named executive vice president, a member of the board and executive committee.

W-K-M Appoints Spencer Manager of Special Projects

C. Ross Spencer has been named to the newly created position of manager, special projects for W-K-M, a division of ACF Industries, Inc. Spencer was formerly with the Oil Center Tool Company and prior to that was associated with the National Supply Company.

Minneapolis-Honeywell Regulator Names Three Industrial Managers

Minneapolis-Honeywell Regulator Company announces the appointment of three industrial managers in its Mid-Atlantic region. Edward J. Klein has been made regional industrial manager with headquarters in Philadelphia; John J. Horner succeeds Klein as industrial manager of the Philadelphia branch office; and Carl F. Boehnlein has been assigned as industrial manager at the Richomnd, Va., branch office.

Klein joined the company in 1935 and has been industrial manager at Philadelphia since 1953. He succeeds O. B. Pyle, who has retired. Horner came to Minneapolis-Honeywell in 1937 as industrial service engineer. Boehnlein joined Honeywell's Brown Instruments Division in 1945, and has been a branch sales engineer since 1950.

Gar Wood Industries, Inc. Names Hetrick Tractor Equipment Manager

Del Hetrick has been named tractor equipment sales manager of Gar Wood Industries, Inc. Hetrick has been with Gar Wood since 1947. He has held positions ranging from assistant product sales manager to his latest position of assistant sales manager, tractor equipment.

Del Hetrick

Prior to joining Gar Wood, he operated his own business in the truck transport field. In his new assignment he will direct sales development and management activities for Gar Wood's new line of crawler tractor equipment.

C-R-C, Inc., Crose Appointed Distributors for Johns-Manville

Crutcher-Rolfs-Cummings Inc., and M. J. Crose Manufacturing Co., Inc., have been appointed distributors of the complete line of Johns-Manville fiber glass pipe wrap products. Products include, Blue Flag reinforcing pipe wrap, Duramat outer wrap and Duratape and Duramesh hand wraps.

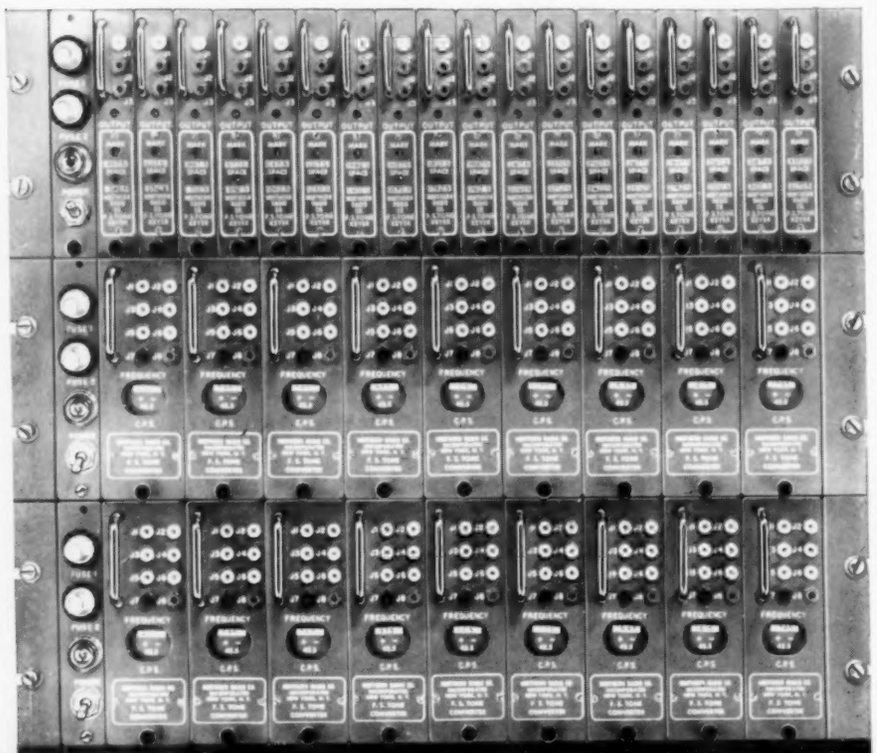
Worthington Corporation Announces Two Appointments

George F. Habach, formerly vice president, engineering, has been promoted to the newly created position of vice president, administration. Rear Admiral Albert G. Mumma, formerly Chief of the Bureau of Ships, United States Navy, succeeds Habach.

Habach will have responsibility for the corporation's staff activities of comptroller, employe and public relations, engineering, manufacturing marketing, purchasing and taxes. He joined the company in 1929 and became vice president in 1955.

Lunkenheimer Opens Los Angeles And San Francisco Sales Offices

Lunkenheimer Co. announces the opening of offices in San Francisco and Los Angeles. Newton R. Crum will be in charge of the Los Angeles office and Lawrence L. Bradford will be headquartered in San Francisco.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NORTHERN RADIO COMPANY, INC.
147 W. 22nd Street, New York 11, N. Y.
Pace-Setters in Quality Communications Equipment
In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario

Go-Devil

NORTHRUP GO-DEVILS

Heavy Duty Model with Neoprene cup or disc drivers

G. A. COTTEN CO.

Manufacturers of NORTHRUP GO-DEVILS & TRANSIT PIPE LINE SCRAPERS

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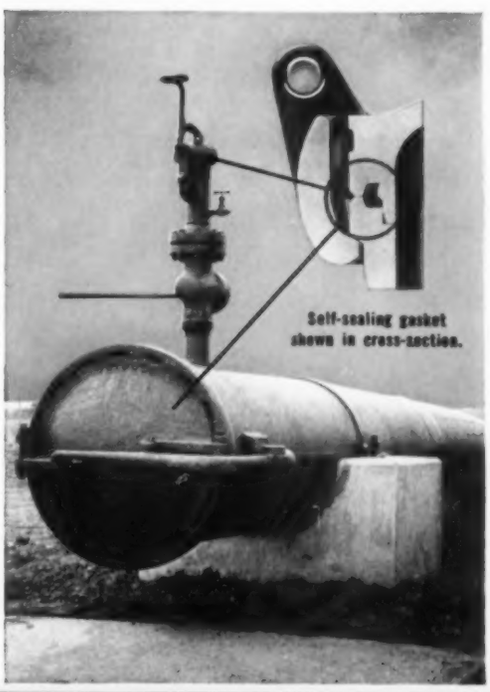
■ $200.00 profit per average direct sale with a well known natl. adv. Pipe Tool. A MUST for every Contractor and Industry using pipe or conduit. No technical knowledge required. Shipped on trial to help get orders. Leads furnished. Write background, reference etc. to box number 54-P, PIPE LINE INDUSTRY, Houston, Texas.

If you are a pipeliner

you'll appreciate this self-sealing gasket in UNIBOLT scraper trap and blowdown closures

Little things . . . like the gasket for a scraper trap or blowdown closure for example . . . can be a big headache. But not this one. It is the self-sealing gasket used in UNIBOLT pipeline couplings. The UNIBOLT design makes line pressure do the sealing. And this design practically encloses the gasket in steel so that when the closure is opened and closed the gasket is hardly disturbed. Made of oil- and gas-resistant Hycar nitrile rubber, this gasket will last indefinitely under normal conditions.

UNIBOLT scraper trap and blowdown closures are hinged for easy operation. Release only two bolts and the closure swings open and shut like a door. No heavy lifting. No time-consuming multi-bolt flanges. Write for complete information.



THORNHILL CRAVER CO.

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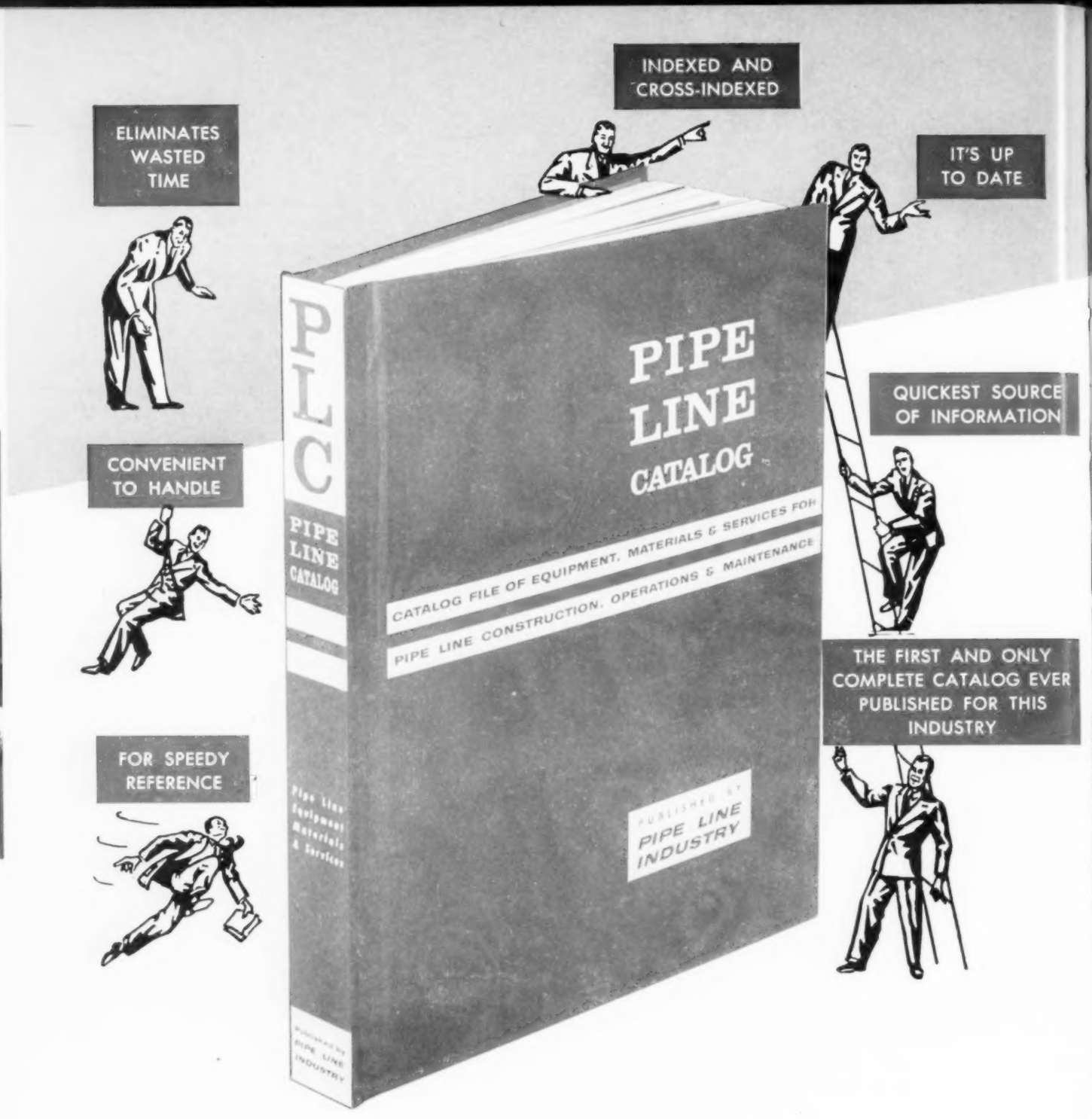
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ELIMINATES WASTED TIME
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QUICKEST SOURCE OF INFORMATION
FOR SPEEDY REFERENCE
THE FIRST AND ONLY COMPLETE CATALOG EVER PUBLISHED FOR THIS INDUSTRY
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PIPE LINE CATALOG
CATALOG FILE OF EQUIPMENT, MATERIALS & SERVICES FOR
PIPE LINE CONSTRUCTION, OPERATIONS & MAINTENANCE
PUBLISHED BY
PIPE LINE INDUSTRY

The only catalog data file being published especially for the Pipe Line Business is a real success. It is serving as a genuine time saver for operating and field executives, superintendents, foremen, engineers, purchasing agents and many others who buy or specify equipment and materials.

More than 165 leading companies have filed their complete or condensed catalogs in this useful volume. Compiled by the manufacturers themselves, this information is arranged and indexed to offer a quick and convenient means of locating *what you want when you want it.*

If furnished to you in individual brochures, bulletins or specification sheets, the information that is now condensed into this composite catalog file would fill the equivalent of several file drawers or book shelves.

On the opposite page you'll find a complete list of the companies that have filed data in the specialized Pipe Line Catalog. When you are looking for sales information, be sure to check these companies in your Pipe Line Catalog. It is the most complete source of buying information available in one volume for this industry today.

ACF Industries, Inc., W-K-M Div.
Aerotec Corp.
Aitken, M. N. Company
Aldrich Pump Co.
Allied Chemical, Plastics &
Coal Chemical Division
Allis-Chalmers Mfg. Co.
Alston Mfg. Co.
American Blower Division
American-Standard
American Cable Div.
American Chain & Cable Co., Inc.
American Chain & Cable Co., Inc.
R-P & C Valve Div.
American Cyanamid Co.
Jefferson Chemical Co. Inc. Subsidiary
American-Marietta Co.
American-Standard,
American Blower Division
Norwood Controls Unit Detroit Controls
Anchor-Wate
Anderson, V. D. Co.
Andrews Tower, Inc.
Automatic Power Inc.

Barber-Greene
Beaird J. B. Co. Inc.
Bethlehem Steel Co. Supply Div.
Bettis Corp.
Bonney Forge & Tool Works
Borg-Warner Corp., Byron Jackson Div.
Bucyrus-Erie Co.
Buffalo-Eclipse Corp., Penberthy
Mfg. Co. Div.
Byron Jackson Pumps Inc. Subsidiary of
Borg-Warner Corp.

Carver-Stimpson Pipe Cleaning Co. Inc.
Caterpillar Tractor Co.
Cathodic Protection Service
Central Plastics Distributing Co.
Centrifix Corp.
Challenge Mfg. Co.
Chance, A. B. Co.
Charles Machine Works, Inc.
Chemetron Corp., Tube Turns Division
Cherokee Laboratories, Inc.
Clark Bros. Co., One of The
Dresser Industries
Coffing Hoist Div., Duff-Norton Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Commercial Iron Works
Cooper-Bessemer Corp.
Corrosion Services Incorporated
Corrosion Rectifying Co., Inc.
Cotten, G. A. Co.
Crane Co.
Crose, M. J. Mfg. Co. Inc.
Crutcher, Rolfs, Cummings, Inc.

Darling Valve & Mfg. Co.
Day, S. D. Co.
Dresser Industries,
Clark Bros. Co. Div.
Magnet Cove Barium Corp. Div.
Duff-Norton Co., Coffing Hoist Div.
Dunlap Mfg. Co.
Duriron Co. Inc.
Dutch Brand Div., Johns-Manville Corp.

Edison, Thomas A. Industries,
Instrument Division
Allan Edwards, Inc.
Elliott Co., Ridgway Division
Elsey Mfg. Co.
Ensign-Bickford Co.

Falk Corp.
Farrel-Birmingham Co., Inc.
Flexitallic Gasket Co.
Fluor Products Co.
Fram Corp., Warner Lewis Co. Div.

These leading manufacturers, suppliers and service companies have filed complete or condensed catalog data in the current edition of the new PIPE LINE CATALOG. See their detailed information in the catalog when you are ready to buy.

Gardner-Denver Co.
Garrett Oil Tools, Inc., Division of
U. S. Industries, Inc.
Gaso Pump & Burner Mfg. Co.
Gasoline Plant Construction Corp.
Gearench Mfg. Co.
General Descaling Co., Ltd.
General Electric Co., Apparatus Division
Gorman-Rupp Co.
Greenhead Sling & Supply Co.
Greenwood Valve Division
Vernon Tool Co., Ltd.
Grove Valve & Regulator Co.

H & M Pipe Beveling Machine Co.
Hamer Valves, Inc.
Hercules Motors Corp.
Homelite, Division of Textron Inc.
Horton Equipment Co.
Hudson Engineering Corp.
Humble Oil & Refining Co.
Hydril Co.

Indus Corp.
Ingersoll-Rand
Instruments, Inc.

Jefferson Chemical Co., Subsidiary of
American Cyanamid Co.
Johns-Manville Corp., Dutch Brand Div.

Kellogg, Communications Division of ITT
Kinzbach Tool Co., Inc.
Knudsen, Vic Co.

L & M Company
Ladish Company
Ledeen Mfg. Co.
Leland Equipment Co.
Lewis, Warner Co. Div. of Fram Corp.
Lloyd Metal Foundry

Magnet Cove Barium Corp.
One of The Dresser Industries
Magnetrol, Inc.
Mallay Tool Service
Maloney, F. H. Co.
MAREP, S. N.
Marsh Instrument Co.
Mason-Neilan Div. of Worthington Corp.
Mathey, C. A. Machine Works, Inc.
Mavor-Kelly Company
McCord Corp.
McFarland Engineering & Pump Co.
McFarland Mfg. Corp.
McKissick Products Corp.
Mercoid Corp.
Midwestern Manufacturing Co.
Midwestern Pipe Line Products Co.
Mine Safety Appliances Co.
Mixing Equipment Co., Inc.
Morris-Young-Owens Co.
Murphy, Frank W. Mfr. Inc.

National Tank Co.
Naylor Pipe Co.
Nickles Machine Corp.
Norwood Controls Unit, Detroit Controls
Division of American-Standard

Oil Well Supply Div. of U. S. Steel

Peerless Mfg. Co.
Pelican Supply Co., Inc.
Penberthy Mfg. Co., Division of
Buffalo-Eclipse Corp.
Perrault Equipment Co.
Petrolite Corp., Tretolite Co. Div.
Philco Corp., Government & Indus. Div.
Philip Carey Mfg. Co.
Pipe Line Development Co.
Pittsburgh-Des Moines Steel Co.
Plastics & Coal Chemicals
Division of Allied Chemical
Portable Bridge & Equipment Co.
Pottermeter Co., Division of
Potter Aeronautical Corp.
Protecto Wrap Co.

Quality March Equipment Co., Inc.

R-P & C Valve Div.,
American Chain & Cable
Ramsey Winch Mfg. Co.
Ray-Test Engineers, Inc.
Reilly Tar & Chemical Corp.
Remco Manufacturing Co.
Ridgway Div., Elliott Co.
Rig Engineers & Fabricators Co., Inc.
Riggs, Wm. L. Co.
Robishaw Engineering Inc.
Rochester Manufacturing Co., Inc.
Rolo Manufacturing Co.
Ruberoid Co.

Shafer Valve Co.
Skinner, M. B. Co.
Sooner Boomer Mfg. Div.
Southern Mill & Mfg. Co.
Sprague Engineering Corp.
Standard Magnesium Corp.
Staytite Co.
Stearns, D. E. Co.
Stearns, N. C. Co.
Steel Forgings, Inc.
Stewarts & Lloyds Ltd.
Superior Equipment Co.
Sewco, Inc.

Textron, Inc., Homelite Division
Thermix Corp.
Thornhill-Craver Co., Inc.
Tinker & Rasor
Tretolite Co. Div. of Petrolite Corp.
Tube Turns Div. of Chemetron Corp.

Union Switch & Signal Div. of
Westinghouse Air Brake Co.
U. S. Industries, Inc., Garrett Oil
Tools, Inc. Division
United States Motors Corp.
United States Steel Corp.,
Oil Well Supply Division
Universal Oil Products Co.

Vereinigte Armaturen-Gessellschaft MBH
Vernon Tool Co., Ltd.
Greenwood Valve Division
Voss, J. H. H. Co., Inc.

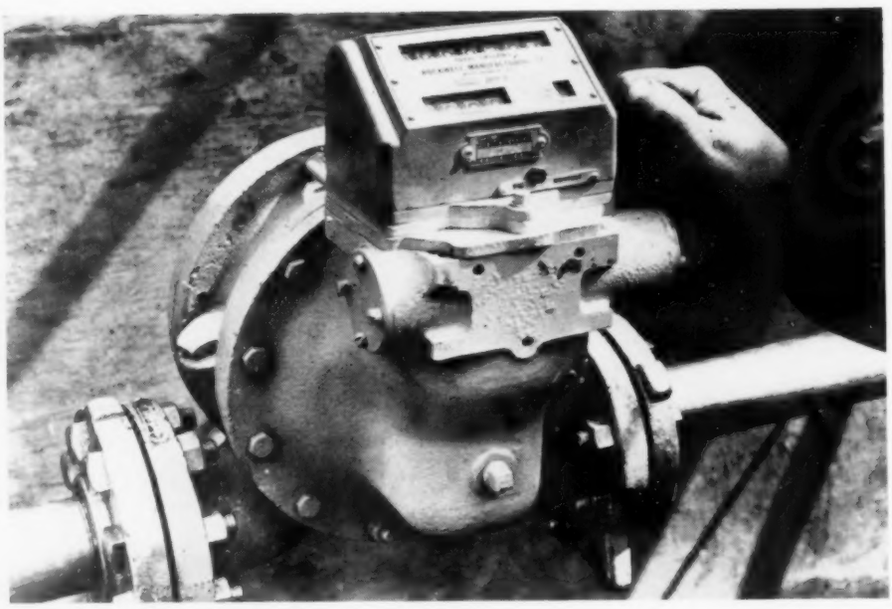
W-K-M Div. of ACF Industries, Inc.
Wachs, E. H. Co.
Waldron, John Corp.
Waukesha Motor Co.
Westinghouse Air Brake Co., Union
Switch & Signal Division
White Diesel Engine Division
The White Motor Co.
Whitmore Homebuilders, Inc.
Wickwire Spencer Steel Division
The Colorado Fuel & Iron Corp.
Wilkinson Products Co.
Williamson, T. D. Inc.
Worthington Corp.
Worthington Corp.,
Mason-Neilan Division

Yale Machine Works

Zeligson Truck & Equipment Co.

PIPE LINE CATALOG

What's New in EQUIPMENT



In-Line Rotocycle Meter

Designed for greater economy and adapability, a rotocycle meter with a special in-line steel case has been introduced by Rockwell Manufacturing Company. The 2S meter has been developed for lease automatic custody transfer systems.

Design advantages feature direct rotary flow, liquid capillary seals which eliminate metal-to-metal contact, low friction construction and minimum flow resistance, variable speed device and teflon shaft seal which protects the register drive mechanism and register proper. The 2S measures flow rates ranging from 20 to 100 gallons per minute. Working pressure is 300 psi with a series 30 flange and 215 psi with a series 15 flange. It is available with non-reset, small reset, large reset or printing register.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Circular Chart Recorders

Daystrom, Inc., has introduced new circular chart recorder-controllers, with either electric or pneumatic controls. The chart recorders employ advanced components, such as the division's recently developed D-Pak unit, and other improvements to provide greater instrument reliability and service in industry.

Pneumatic controls, in models 6,836 potentiometer and 6,856 Wheatstone bridge, are available as universal controller, proportional plus automatic reset, or proportional with automatic reset and derivative; proportional band adjustability—2 to 300 percent.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Medium-Size AC Motors

General Electric's ac motor & generator department announces availability of a new line of medium-size motors. Many combinations of motor features can be made to meet exacting requirements of petroleum facilities and many other industrial areas.

The "custom 8,000" general line with ratings from 100 to 600 horsepower, features an entirely new "square look." A number of accessory kits such as splash-proof louvers or space heaters to protect a motor in damp atmospheres are also available for quick conversions in the field. Several insulation systems are available with the motors.

(This item supplements General Electric data on pages 199-202 of the Pipe Line Catalog, Second Revision.)

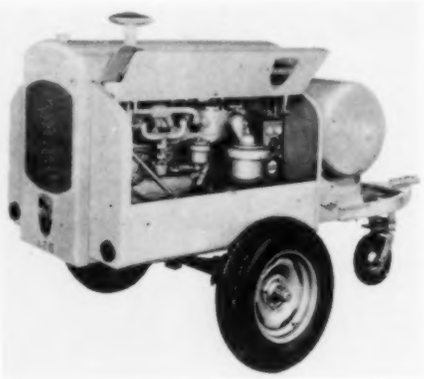
For more data, circle **No. E3** on Readers' Service Card, last page this issue.

Two-Way Radio

General Electric announces an advanced design of transistorized two-way radio equipment to be marketed immediately. The new transistorized line ranges from the 75-watt category down to the 30 and 10-watt units in sizes as small as 8⅝-inches wide, 12-inches long and 4-inches high. Only three tubes are used in the lower catagories and four in the 30- and 75-watt models. A primary design consideration was lower standby drain, an important element for mobile radio users who utilize two-way radio when out of their vehicles.

(This item supplements General Electric Co. data on pages 199-202 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E4** on Readers' Service Card, last page this issue.



Air Compressor

A single-stage, piston-type portable air compressor powered by a gasoline engine has been developed by Le Roi Division, Westinghouse Air Brake Company. With a 125 cfm capacity, the rated compressor speed is 1,300 rpm.

The overhead valve four-cylinder engine and two-cylinder compressor have replaceable wet-type cylinder sleeves for longer wear and low maintenance cost. The model 125 engine-compressor unit has only one crankcase and one crankshaft, eliminating need for a clutch or coupling. There is also only one pressure type lubricating system.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Interlock Switch

A new subminiature door interlock switch, designed for use on high-voltage cabinets and radio, X-ray and other electronic cabinets, has been introduced by Micro-Switch, Division of Minneapolis-Honeywell Regulator Company. The switch is used to automatically cut off

New Ford F-100 4-wheel drive Styleside pickup handles heavy loads and makes its own road.

Now from FORD...America's lowest-priced 4-wheel drive pickups... *Six or V-8!*

ALL FORD-BUILT . . . FACTORY-ENGINEERED . . . FOR GREATER SAVINGS!

Go *Ford*-ward for 4-wheel drive performance at big Ford savings. They're factory-engineered for extra stamina, and all Ford-built with your choice of economical Short Stroke power—Six or V-8.

There's new versatility too, with two power take-off points in the transfer case to drive winches, saws, diggers, or other equipment. And there's new driving ease. You shift smoothly between 2- and 4-wheel direct drives while moving.

Ford 4-wheel drive trucks are available in ½- and ¾-ton pickups, chassis-cabs and ¾-ton stake models. See your Ford Dealer . . . save hundreds of dollars on America's lowest-priced 4 x 4's with Six or V-8!

FORD TRUCKS COST LESS

LESS TO OWN . . . LESS TO RUN . . . LAST LONGER, TOO!

power when the cabinet service door is opened. By pulling the plunger to the maintained contact position, it is possible to check circuits with the power on. The plunger returns to normal operation position when the door is closed.

Electrical rating for 125 or 250 volts ac is 5 amps. At 30 volts dc, inducting rating is 3 amps (sea level) and 2.5 amps (50,000 feet) with resistive load of 5 amps. Maximum inrush is 24 amps.

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

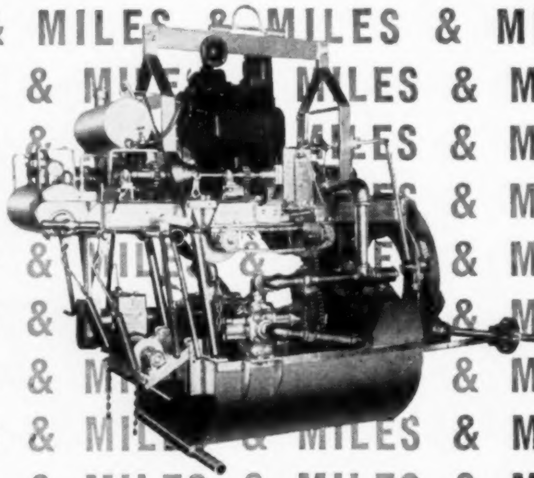
Small Turbocharger

A small, 24-pound turbocharger has been developed for International Harvester's TD-9 crawler tractor. Installed on the new D-282 six-cylinder diesel engine, the 7¾-inch diameter turbocharger boosts power output by 23 percent.

In the turbocharging operation, exhaust gases are harnessed to increase the volume of air fed into the engine, resulting in more power and fuel economy. This turbocharger accomplishes this by supplying compressed air to the engine intake manifold. The unit consists essentially of a single-stage centrifugal compressor, mounted on a common shaft with a single-stage-radial inflow turbine, a one-piece main housing, a turbine housing and compressor housing. The turbine wheel, which drives the compressor impeller, is actuated by engine exhaust gases.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

PROVED BY MILES & MILES



OF DEPENDABLE WRAPPING ON PIPELINES ALL OVER THE WORLD

- **OVER-ENGINEERING MINIMIZES DOWN TIME**
- **PRACTICAL DESIGN MINIMIZES "HOLIDAYS"**

When compared to the industry, Perrault machines for large-diameter pipe are designed with: More power, heavier transmissions, bigger clutches, stronger speed reducers, greater pumping capacity; and they are equipped with full-width rubber crawlers. Even with these heavier components, Perrault machines are lighter in weight. Models available for all pipe sizes; any coat and wrap combination. Write for complete details.

EVERY THING FOR THE PIPELINER!

Line Traveling and Stationary Coating and Wrapping Machines, Cleaning and Priming Machines, Pneumatic Clamps. Perrault-American Tar-Heating Kettles, Patchpots, Burners, parts and accessories. Esco Digging Teeth Pipe Protection Materials — Kraft, Asbestos Felt, Glass Wrap and Rock Shield. General Supplies—Hooks, Blocks, Line-Up Clamps, Sling Belts, Cradles, Hand Tools, materials, supplies and equipment of every sort . . . Everything for the Pipeliner.

PERRAULT *Equipment* CO., INC.

W. O. DIXON, Sole Owner

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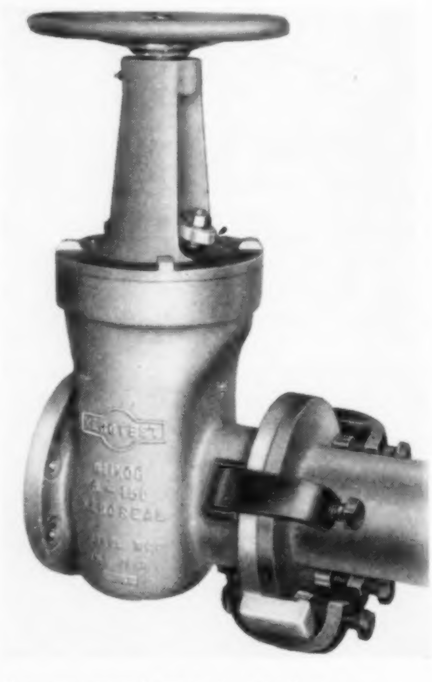


Improved Dock Valves

Providing for an easier and more practical method of connecting cumbersome flexible tanker and barge hoses to manifold valve flanges, Kerotest Manufacturing Company has introduced its newly designed "Dock Valves."

Essential parts include an extended flange which allows the workman handspace between body and flange. A nominal number of lugs extending beyond the lower lip of the stationary valve face is provided. This addition allows the workman to rest hose flange until it is properly aligned. Also modified "C" clamps were attached to the extended flange; clamps can make a completely tight joint between flanges, eliminating the necessity of aligning holes or use of bolting.

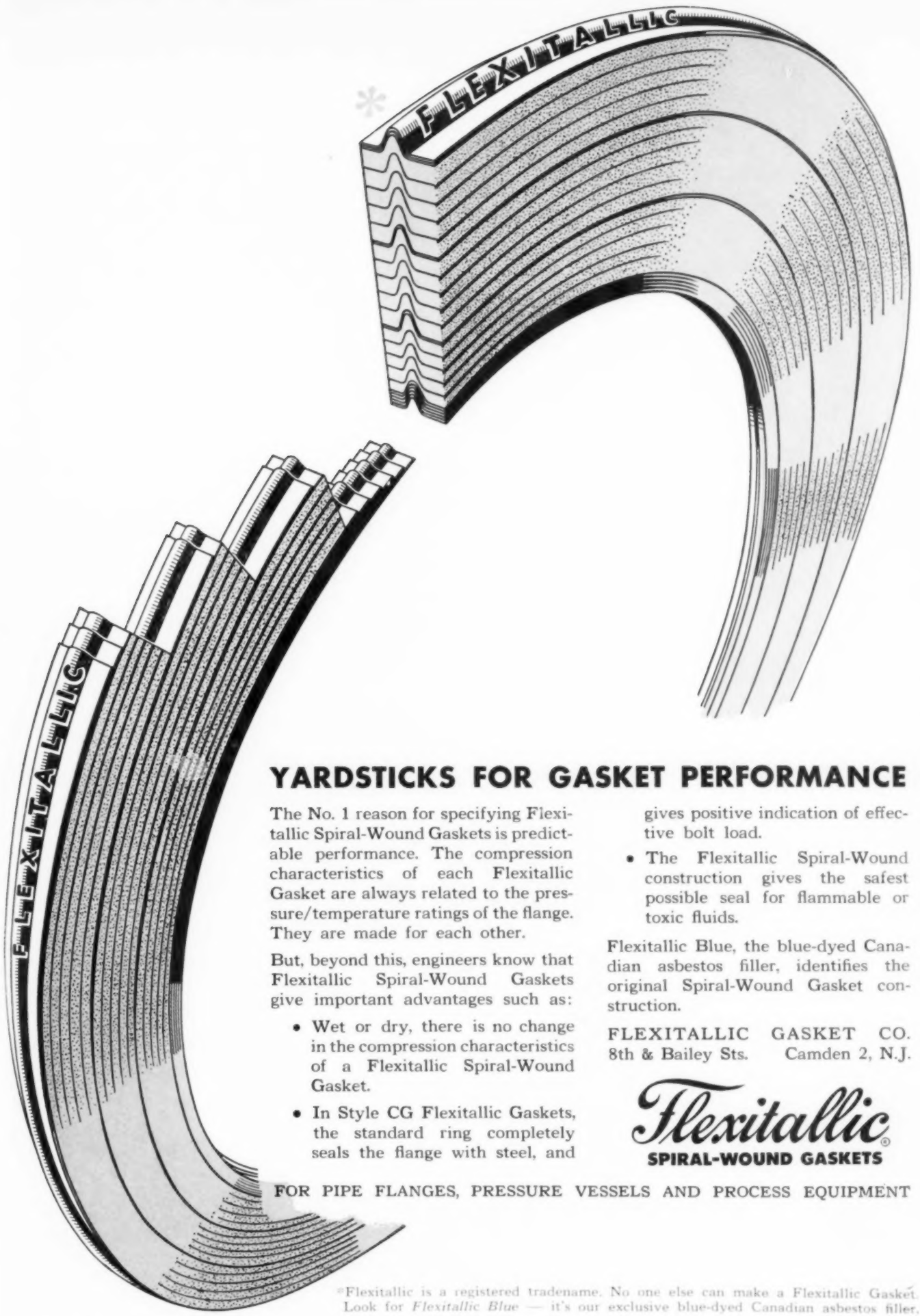
For more data, circle **No. E8** on Readers' Service Card, last page this issue.

Pipe Sealant Tape

A chemically inert tape, designed to seal and permanently lubricate pipe joints, has been announced by Minnesota Mining and Manufacturing Company. The pipe sealant tape, 547, is an unfused film tape, available in 3- and 4-mil calipers, which can be applied in seconds and conforms to all types of pipe threads and fittings.

Although non-adhesive, it is sufficiently cohesive to stick to its own glossy surface. It is not affected by oil traces or other lubricants in the steam line, according to the manufacturer.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.



YARDSTICKS FOR GASKET PERFORMANCE

The No. 1 reason for specifying Flexitallic Spiral-Wound Gaskets is predictable performance. The compression characteristics of each Flexitallic Gasket are always related to the pressure/temperature ratings of the flange. They are made for each other.

But, beyond this, engineers know that Flexitallic Spiral-Wound Gaskets give important advantages such as:

- Wet or dry, there is no change in the compression characteristics of a Flexitallic Spiral-Wound Gasket.
- In Style CG Flexitallic Gaskets, the standard ring completely seals the flange with steel, and gives positive indication of effective bolt load.
- The Flexitallic Spiral-Wound construction gives the safest possible seal for flammable or toxic fluids.

Flexitallic Blue, the blue-dyed Canadian asbestos filler, identifies the original Spiral-Wound Gasket construction.

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8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered tradename. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

P.D. Meter

Ralph N. Brodie Company has introduced its largest positive displacement meter which has been designated the B-142. The meter stands 9-feet high and boosts a working capacity of 20,000 barrels per hour at 150 psi.

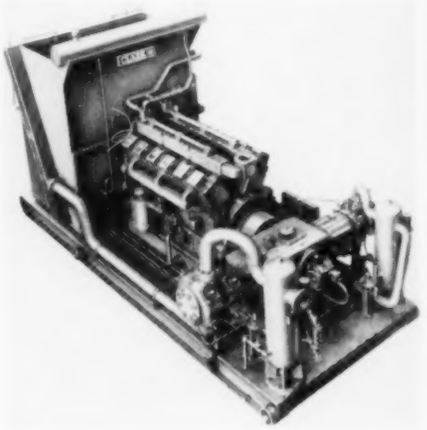
Designed to measure crude and refined products with high precision and at full rated capacity, the meter employs Brodie's BiRotor metering principle.

For more data, circle **No. E10** on Readers' Service Card, last page this issue.

Packaged Field Compressor

Designed for single or two-stage applications where greater capacity is required in a two-cylinder machine, Clark Bros.'s new packaged compressor ranges from 200 to 350 bhp.

The Model CFB features a 5-inch stroke, two-cylinder, balanced/opposed compressor completely self-contained. It can be used for gas lifting, boosting, repressuring, pressure maintenance, field gas gathering and pipe line testing. Operating at 1,000



rpm, the unit is directly connected to the driving engine by a simple rubber block type coupling. Belt and gear drives are eliminated; the compressor package can be mounted on any support that will hold its weight.

(This item supplements Clark Bros., Co. data on pages 89-92 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Aluminized Shield

An aluminized fabric named "Scotch-Shield," developed for greater resistance and longer-lasting heat-reflective qualities, has been introduced by Minnesota Mining and Manufacturing Co.

The shield can be used as a fire-fighting suit or for other industrial uses involving unusual abrasion and intense radiant heat. The Type 75 aluminized fabric consists of a micro-thin layer of pure aluminum bonded to an underwriters' grade asbestos weighing 1.2 pounds per square yard.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

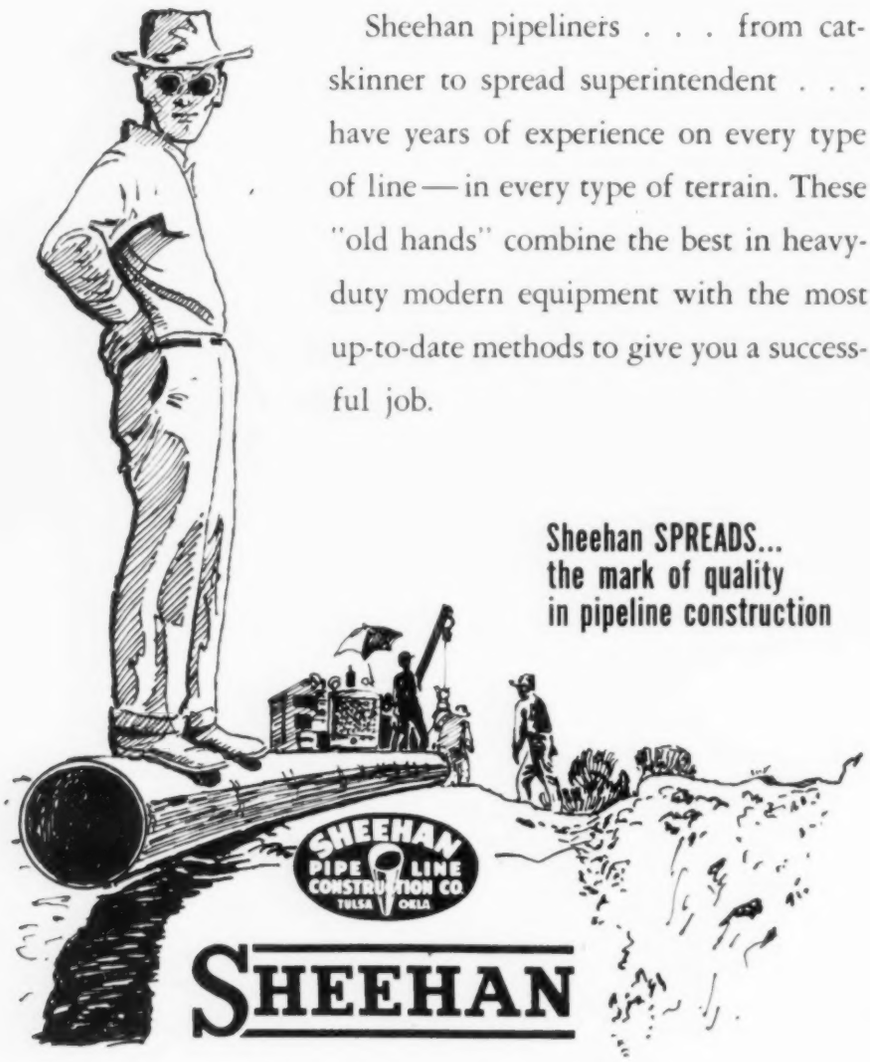
Rectifier Type Welder

An "all weather construction" model SRH dc rectifier type welder is designed to last under rugged conditions.

Features of the models which come in 200, 300 and 400 amperes, include: The entire transformer, control cores and coil assemblies are preheated, dipped in varnish and baked; three Cam-Lok receptacles are used for welding terminals; rectifiers have double coat of polyester finish; base and

pipeliner . . .

. . . the "make-or-break" factor in pipelining



Sheehan pipeliners . . . from cat-skinner to spread superintendent . . . have years of experience on every type of line — in every type of terrain. These "old hands" combine the best in heavy-duty modern equipment with the most up-to-date methods to give you a successful job.

Sheehan SPREADS... the mark of quality in pipeline construction

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NATIONAL BANK OF TULSA BUILDING

TULSA, OKLAHOMA

An OFFSHORE first

from SIE *and Dresser!*

LAKE MARACAIBO

wells under

PUSH BUTTON CONTROL

Eliminates ALL operators on platform

SIE solid state electronic control systems provide remote well head and flow station control. Complete well test programming, data logging, alarms and continual data scan give you *every* necessary control function for an *entire* well complex — at the push of an SIE button!

Only specialists in control devoted to the Oil Industry

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.

A DIVISION OF DRESSER INDUSTRIES, INC.

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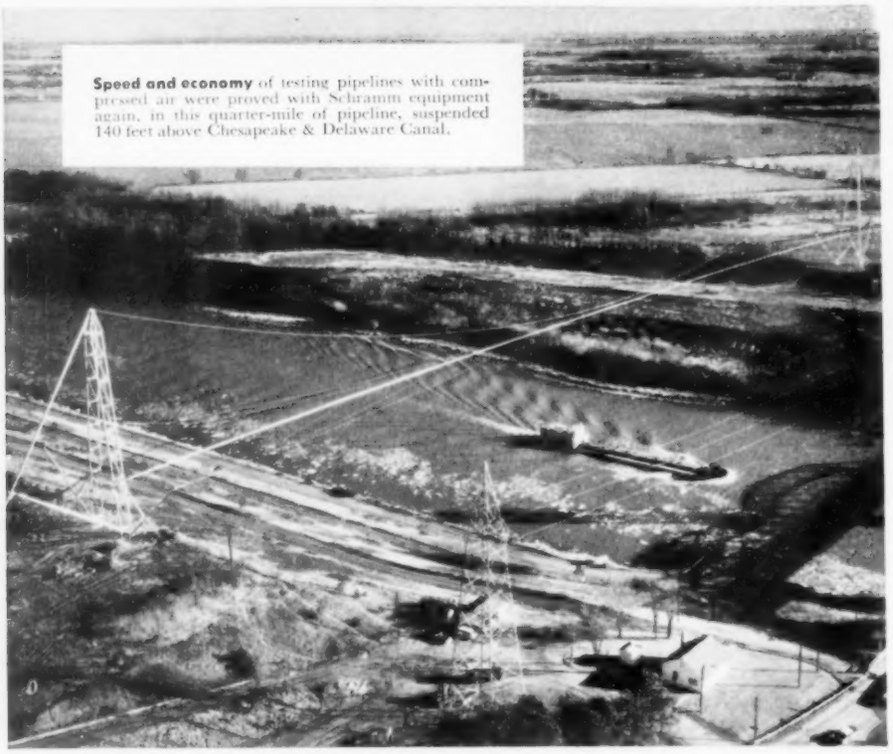
Write Rex Grey for your personal copy of . . .

"Control . . . the answer to increased pipe line profits"

SIE



Speed and economy of testing pipelines with compressed air were proved with Schramm equipment again, in this quarter-mile of pipeline, suspended 140 feet above Chesapeake & Delaware Canal.

CONTRACTOR WHIPS PROBLEMS OF TIME, WEATHER, WEIGHT:

Tests 1760′ suspension gas line in 3 hours with compressed air

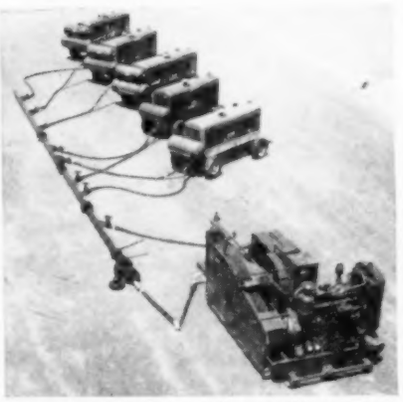
It was February, 1959, and it was cold. Customers needed gas . . . *fast*. Hydrostatic testing was out of the question for this last and aerial link in the Eastern Shore Natural Gas Company's 124-mile pipeline. Water would not only freeze and delay opening of the line, its weight would create a hazard for the supporting structure. The contractor sidestepped every problem, by using compressed air from Schramm pipeline testing equipment rolled to the site on Schramm Tractor Trailers. Entire job was done in 3 hours, 5 minutes . . . quick, clean, positive! Send for full details on how Schramm can work for you, too!

See the Yellow Pages for local Sales, Service and Rentals of Schramm Air Compressors.

Schramm, Inc.

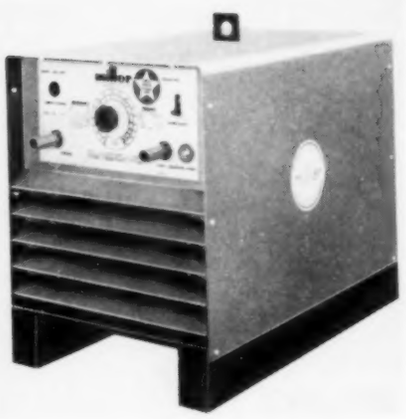
MANUFACTURERS OF AIR COMPRESSORS

737 North Garfield Ave. • West Chester, Pa.



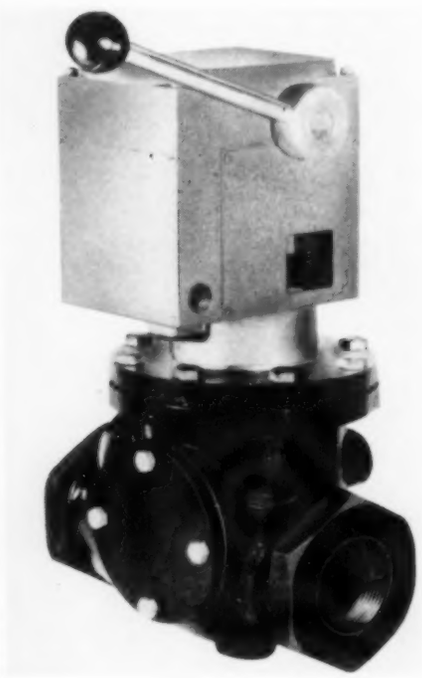
Rent or buy. Schramm supplies everything you need for any testing job: three Schramm 600 cfm Portable Compressors (*rear units*), two 1-D Booster Units (*center*), and one PPC Booster Unit. Operates to 1500 psi. Rental includes delivery to site, experienced operating team. Buy, and you can use compressors for any air requirement.

Move right in with Schramm Tractor Trailers. Save set-up time, end headaches of working with water. Write for full information, including estimating chart.



sheet metal parts are completely phosphatized and painted; cooling rings on fan motor are phosphatized and dipped in baking varnish before assembly; and fan blades have a protective coating. Miller Electric Mfg. Co. announces that the procedures have withstood sustained salt spray tests.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

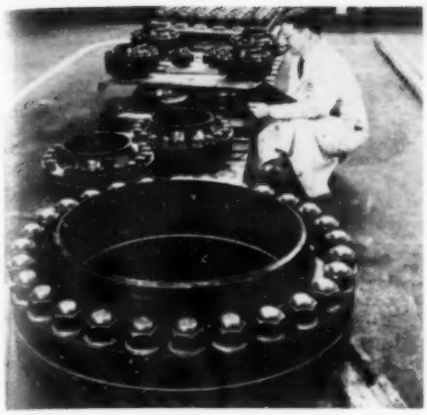


Full-Flo Valves

General Controls announces a newly designed valve which utilizes straight-through, non-turbulent flow with a fail-safe shut off. Advantages of the hi-flo design includes an increase in flow because inner valve in open position is completely withdrawn from main gas stream.

The valves are built with two types of actuators: manually reset and electrically reset. All valves are equipped with vertical self-cleaning seats to prevent accumulation of particles or contamination that would affect tight seating of valve needed for complete enclosure. Pipe sizes from 1 inch to 6 inches are accommodated.

For more data, circle **No. E14** on Readers' Service Card, last page this issue.



Pre-Assembled Joints

Availability of pre-assembled insulated flange joints in all pipe line sizes has been announced by Tube Turns Division of Chemetron Corporation. The shop assembled joints help eliminate difficulties in field assembly of insulated flanges used to check electrolytic corrosion in underground piping.

Dielectric insulating gaskets, sleeves and washers eliminate any metal-to-metal contact that would permit flow of either induced or self-generated electric current.

(This item supplements Tube Turns, Division of Chemetron Corp. data on pages 446-447 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

Portable Rotary Compressor

A 125-cfm Gyro-Flo portable rotary compressor has been introduced by Ingersoll-Rand. Some of the features of the portable compressor include: simplified, more efficient compressor system, automatic drainage of oil from cylinders when unit is shut down, safety shutdown on compressor, provision for inspection of all rotor vanes, and fuel and air tanks under housing and lockable cover. Power is supplied by an 1800 rpm Continental Red Seal engine, diesel or gasoline.

(This item supplements Ingersoll-Rand data on pages 241-248 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E16** on Readers' Service Card, last page this issue.

Low Pressure Pumps

Two models have been added to Wilson-Snyder's line of reciprocating and centrifugal pumps. The 500-horsepower centrifugal pump is capable of delivering 12,000 gallons per minute to a 150-foot head. The 28.5-hp general service reciprocating pump has a capacity of 126 gallons per minute.

The centrifugal unit is a 16-inch double volute, double suction pump, designed primarily for water supply transfer service and other large capacity, relatively low-pressure operations.

The smaller model, 246-P, develops a maximum working pressure of 600 psi.

For more data, circle **No. E17** on Readers' Service Card, last page this issue.

Shovel-Crane

Thew Shovel Company announces a new 18-ton Moto-Crane with a new 180-foot carrier providing mobility and sturdiness for heavy-duty work.

The MC-218 is convertible to shovel, crane, clamshell, dragline, and hoe. The turntable can be mounted in two positions on the carrier for either maximum crane capacities or for the best digging ranges. The Lorain square-tubular-chord boom used on the 218 permits greater lifting capacities and increased bucket reaches to do more jobs faster.

For more data, circle **No. E18** on Readers' Service Card, last page this issue.

New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers' Index. Simply circle code numbers of items desired—sign and mail card.

Offshore Barge

A brochure giving complete information and complete list of equipment facilities of the offshore barge "Magic" is now available from Commonwealth Oil Company.

In constructing offshore lines the "Magic" has laid up to 6,500 feet of 12-inch concrete coated pipe in 75 feet of water in a 24-hour day.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Small Valves

Kerotest Manufacturing Company has released a four-page section to its new steel catalog. The catalog covers the company's line of small valves for general application.

Information pertaining to working pressures, specifications, construction features, and suggested applications are included.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

There's VERSATILITY in your PIPE LINE SERVICE and **Portability** *with...*

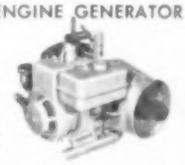
US

Portable U.S. Versa-Trailer standby emergency power units in sizes from 10 kw to 35 kw capacity provide single phase power for lights and 3-phase power for other requirements.

Versatile mobile power units provide for foolproof selection of desired current with selector plugs and cables.

Pipe Lines use convenient lightweight generating sets for lights, portable tools. Rugged construction.

ENGINE GENERATOR



Portable blowers are especially suited for ejecting smoke, fumes, stale, contaminated air, and for purging tank cars, field storage tanks, etc. Motor driven or engine blowers are available.

ENGINE BLOWER

MOTOR DRIVEN BLOWER

for complete information write . . .

UNITED STATES MOTORS CORPORATION
LIGHT US POWER
OSHKOSH · WISCONSIN

UNITED STATES MOTORS CORPORATION

112 W. 5th Ave. / Oshkosh, Wis.

Write for Bulletin

PIPELINE VENTS AND MARKERS

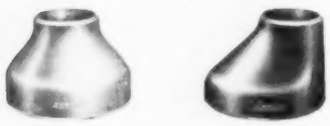
FLEET-LINE CO.
P. O. BOX 276-K
SHREVEPORT
LOUISIANA

Write for Specifications Folder

FLEET-LINE

WELDING FITTINGS

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.



SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Complete encirclement saddles.

Fast interested service.
Write for Literature.

STEEL FORGINGS, Inc.

P. O. Box 276K • Shreveport, La.

Electrical Connectors

Crouse-Hinds Company has published a 48-page bulletin titled "Ark-trol Electrical Connectors" describing a complete new line of plugs and receptacles in environment-resistant construction.

Type RPE connectors are moisture-proof, shock-insulated, dust-tight, and corrosion-resistant. All connectors operate in a temperature range of —80° F to 225° F, and withstand pressure of 300 psi external and 200 psi internal. Completely foolproof polarization of shell to shell and insert assembly is an exclusive feature of the Ark-trol line, as is the contact design permitting attachment of conductors before assembling in the insert.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Tubular Goods

Phoenix-Rheinrohr has published a bulletin describing the tubular products it manufactures. The two-color, highly illustrated booklet includes sections on casings, long and short couplings, tubing, casing and tubing with Omega joints and line pipe.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Wire Feed Equipment

Arcos Corporation has issued a four-page bulletin pertaining to Arcosarc flux-cored electrodes and semi-automatic wire feed equipment. The manual describes the simple, portable equipment with non-electronic controls needed for CO_2 semi-automatic and automatic welding of mild and low alloy steels. Advantages of the Arcosarc process are outlined. Bulletin also explains basic operating principles by which it works.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Four-in-One Tractor

Features of the International Harvester Drott TD-15 four-in-one skid shovel are described and illustrated in a 16-page, two color catalog.

By moving a "machine selector" lever the operator has a choice of bulldozer, scraper, clamshell or skid shovel unit. A section of the bulletin is devoted to the exclusive Hydro-Spring, which reduces the effects of shock forces on the tractor and operator.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

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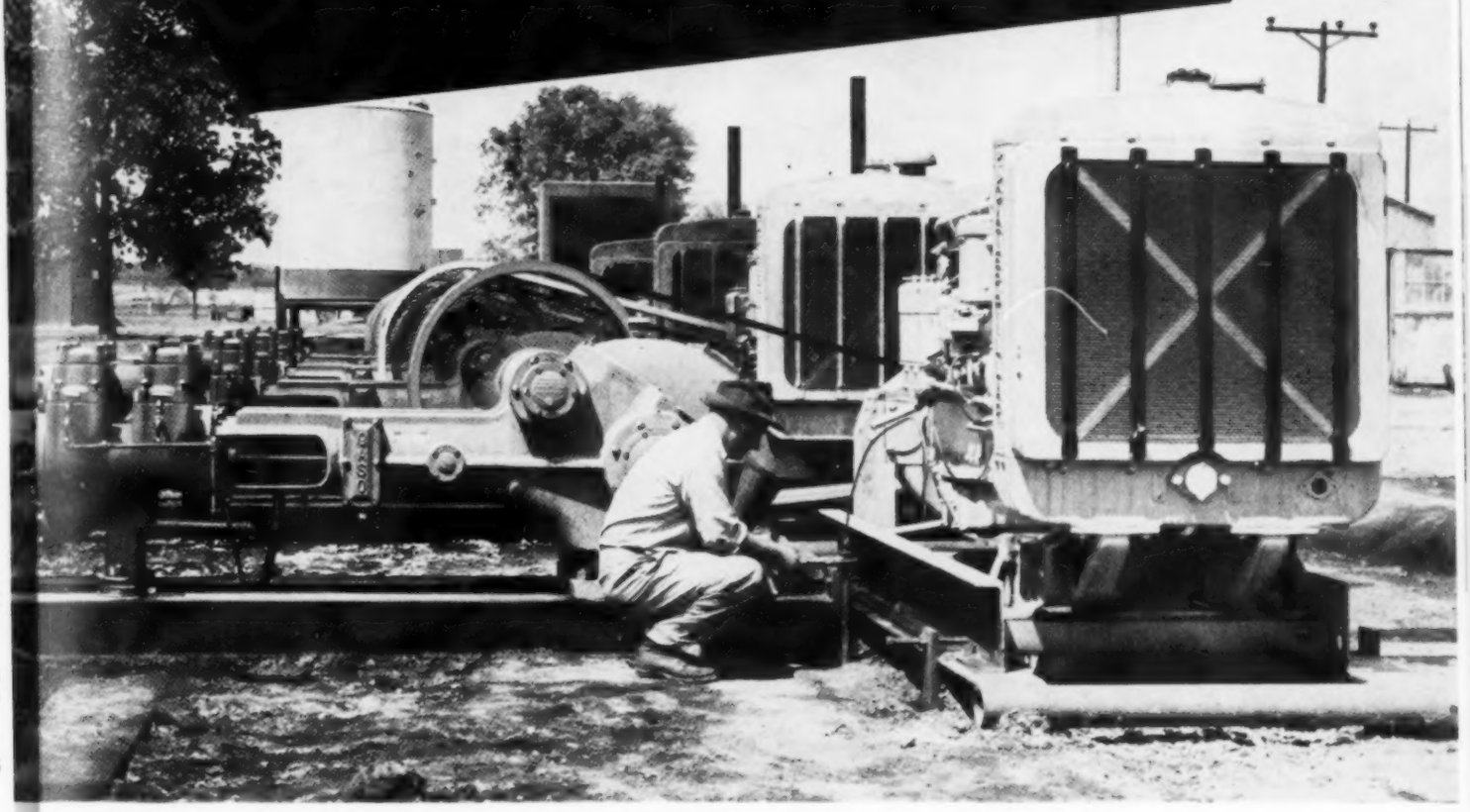
NOTICE OF 44th ANNUAL EXTRA DIVIDEND



In 1959, as in 43 previous years, users of Gaso Pumps will receive extra dividends on their investment . . .

—an EXTRA degree of operating efficiency, resulting from the fact that Gasos are available in models precisely suited to individual needs.

—an EXTRA measure of economy, stemming from Gaso's traditionally low maintenance cost.

—EXTRA years of life, proved by the fact that thousands of Gaso Pumps long past normal "retirement" age are still delivering a full quota of service.

Extra dividends on their investment are another reason why so many companies specify Gaso Pumps as "standard equipment" in their capacity range.

Write for our latest catalog.

DISTRIBUTORS:

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Long Beach, Calif.—Power Pumps, Inc.
Casper, Wyoming—Lufkin Foundry & Machine Co.
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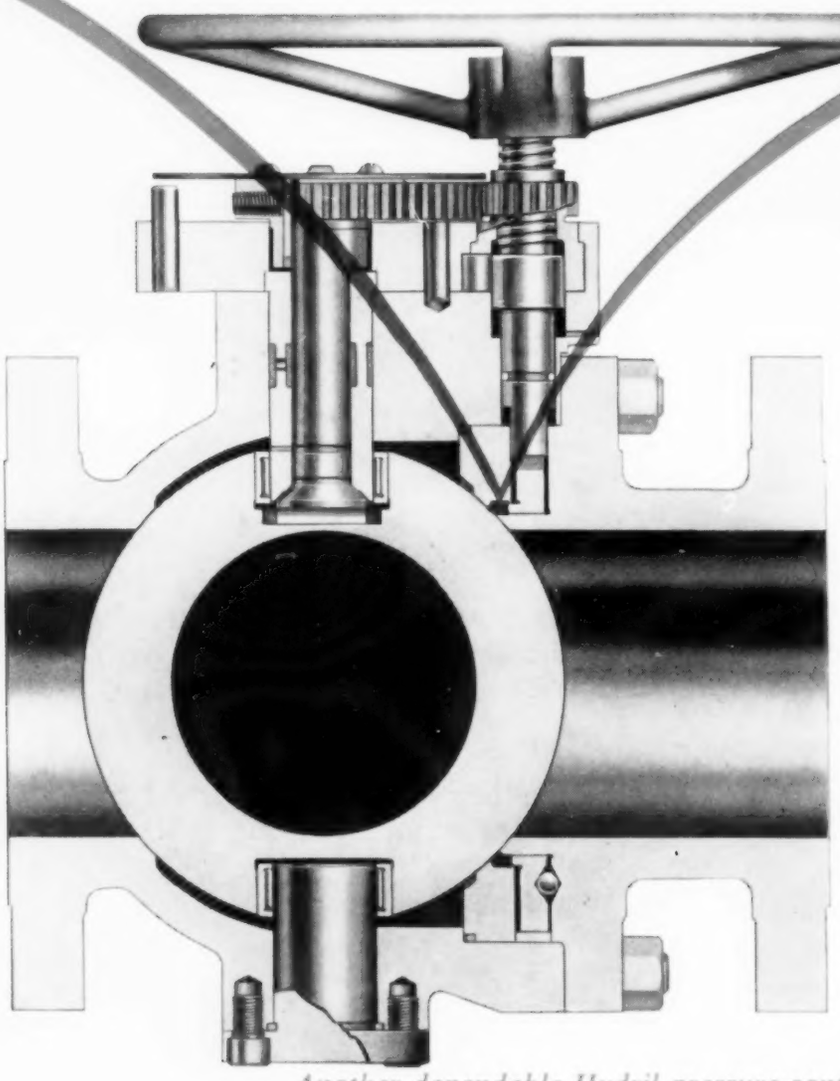
EXPORT OFFICE: EMPIRE STATE BUILDING, NEW YORK, NEW YORK

GASO PUMPS
for every oil industry need

100th Anniversary of Oil in America 1959 **44th Anniversary of Gaso Leadership**

HYDRIL BALL Type "K" PLUG VALVES

COMPRESSIBLE PORT SEAL
provides
POSITIVE SHUTOFF



Hydril Ball Plug Valves achieve a positive seal against pressure from either direction because the fully enclosed packing ring is *mechanically pressed* tightly against the spherical plug and its seat after the valve is closed.

No other valve has this *controlled* port sealing feature.

SEEP-PROOF, BUBBLE PROOF. The fully confined packing ring is tightly squeezed against plug and seat so that it flows into surface imperfections, around sediment . . . even closes scratches that may occur on the sealing surfaces.

PORT SEAL RETRACTS for easy operation. The mechanical pressure against the port seal is released before plug rotation commences to eliminate seal ring wear and assure easy operation.

Write for catalog describing Hydril Ball Plug Valves in full detail.

Another dependable Hydril pressure-control product

HYDRIL COMPANY

714 W. Olympic Boulevard, Los Angeles 15, California